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ABSTRACT

In January 1985, Employment and Immigration Canada funded a pilot project in New Brunswick for the development and testing of an Interprovincial Computerized Examination Management (ICEM) System. The resulting system is comprised of a dual interprovincial and provincial item bank facility, a software component offering the option of computerized skill testing, and a package for the administration and maintenance of the testing program. The ICEM permits: (1) entry, editing, deletion, and selective retrieval of test items; (2) automatic and manual computer-generation of examinations in various formats; (3) registration of interprovincial examinations in files that provide instant access for updating, eligibility decisions, and statistical reports; (4) correct scoring of hard-copy and on-screen examinations; and (5) creation of a program for performing statistical item and examination analyses. This report outlines the objectives of the ICEM system, its hardware and telecommunications requirements and costs, its advantages and disadvantages, user training, and topics that require further discussion (i.e., system security, size of graphics, and validition of items for inclusion in the bank). The bulk of the report consists of appendixes containing "Interpretation of System Specification System Sheet for Item Banking Project," by Brenda Mulherin; "Field Test of Exams"; "Interprovincial Standards Program Coordinating Committee Policy Statement"; and "Graphics for a Computerized Examination Management System." (EJV)

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REPORT

OF THE

NATIONAL SUB-COMMITTEE

TO THE

INTERPROVINCIAL STANDARDS
PROGRAM COORDINATING COMMITTEE

ON THE

INTERPROVINCIAL COMPUTERIZED
EXAMINATION MANAGEMENT SYSTEM

OCTOBER 1987

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Preface

In 1983, out of concern for improving, validating and securing examinations, the Interprovincial Standards Program Coordinating Committee responsible for interprovincial examination standards, recommended that a sub-committee investigate the feasibility of a computer assisting in overcoming the problems. A concept of "Computerized Item Banking" was developed for interprovinical examinations. In the months that followed the sub-committee devoted their time to identifying the parameters of an item bank and in preparing a submission for conducting a pilot.

In March, 1984, their submission was tabled at the Provincial /Territorial Deputy Ministers meeting, and essentially recommended the following:

(1) approval to conduct a pilot project in computerized testing, and

(2) a budget of $116,000.00 to finance it.

Supported in principle by the Deputy Ministers, the sub-committee's recommendations were placed on the agenda of the Provincial/Territorial Ministers meeting on March 7, 1984. Approval was given to conduct a pilot project on the computerization of examinations with a budget of $112,000.

Immediate action was taken by the Interprovincial Standards Program Coordinating Committee to recommend to C.E.I.C. that New Brunswick, under the guidance of the national sub-committee for computerized testing, carry out the pilot project. On January 31, 1985 an agreement to produce a computerized testing system, was signed between the Province of New Brunswick and Employment and Immigration Canada. Experience has proven that the funding provided was insufficient, but nevertheless New Brunswick continued to support the project to the end of the pilot.

This report is the result of the national sub-committee's efforts to find answers to the problems posed by the Interprovincial Standards Program Coordinating Committee in 1983.

National Sub-Committee

Composition of the national sub-committee consisted of Mal Cook, Alberta, Hans Kotiesen, from Ontario, Paul Montpetit representing CEIC, André St. Jean and Gilles Charbonneau from Québec, and Sid Harris and Richard Ingram from New Brunswick.

Acknowledgements

As in any major endeavour there are many to thank for their help. These people, and the areas in which they contributed to the "Interprovincial Computerized Examination System" are:

Past Committee Members:

Gordon Booth ..... CEIC
Brian Carr ..... Northwest Territories
Howard Hewer ..... Ontario
Tom Watson ..... CEIC
Bill Waugh ..... New Brunswick

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Executive Summary

An active search, guided by the Interprovincial Standards Program Co-ordinating Committee (I.S.P.C.C.) began in 1983 for a system that would improve various aspects of "Red Seal" examination development and administration. In January 1985, Employment and Immigration Canada agreed to fund a pilot project in New Brunswick for the development and testing of an Interprovincial Computerized Examination Management (ICEM) System. This pilot project was overseen by a national sub-committee of the I.S.P.C.C., composed of representatives from Alberta, New Brunswick, Ontario, Quebec, and Canada Employment and Immigration.

A computer-based system has now been completed and tested with respect to the following major processes:

1. Creation of a dual interprovincial and provincial item bank facility which permits entry, editing, deletion and selective retrieval of items. Volume is virtually unlimited.

2. Automatic and manual computer-based generation of examinations, complete with graphics, in various formats: English, French, Metric and Imperial measurement, hard-copy and on-screen administration. The equivalency of automatically generated examinations and the "user-friendliness" of on-screen examination administration were also confirmed.

3. Registration of interprovincial examination candidates in files that provide instant nation-wide access for updating, for eligibility decisions, and for statistical reports.

4. Correct scoring of hard-copy and on-screen examinations and updating of candidate files.

5. Creation of a program for performing statistical item and examination analyses, with the remaining reporting features to be added at a later date.

The report also identifies, with costs, the options available to potential users for joining the system; cites advantages and disadvantages of a computer-based system; discusses user training; and provides the background to several issues requiring further discussion in the areas of system security levels, graphics, and item validation.

Finally, the national sub-committee makes a number of recommendations related to the operation of the system.

System Objectives and their Achievement

Piloting of the Interprovincial Computerized Examination Management System was based on achieving and testing the objectives outlined in the system specification sheets dated February 8, 1985 (revision 1:01) (see appendix A). The five objectives and confirmation of their achievement are given below.

OBJECTIVE #1:

To create an item bank to include a data entry and maintenance program which will allow examination officers from across Canada to enter, edit, and delete items on a computerized item bank.

In direct interaction with the system, national sub-committee members confirmed achievement of this objective by:

(a) ensuring that all provinces/territories would be able to view an interprovincial item bank, but only the host province/territory would be able to edit the items;

(b) ensuring that one province cannot, without permission, view or access another province's/territory's bank; and

(c) entering an item in the system, performing maintenance on it and finally deleting it.

OBJECTIVE #2:

To automatically by computer generation and manually with computer assistance produce examinations in either or both official languages; in either or both units of measurement; and in traditional hardcopy format or electronically by computer terminal.

In direct interaction with the system national sub-committee members confirmed achievement of this objective by:

(a) manually and automatically creating English, French, and bilingual examinations;

(b) verifying that the manual examinations were arranged according to committee members' specifications;

(c) viewing binders of computer graphics for quality and accuracy that supplement questions in the bank; and

(d) trying unsuccessfully to select items for a manually generated examination that were flagged inappropriate for use on an examination.

In order to evaluate the quality of examinations produced by the system, further validation of this objective was conducted by computer generating and field testing two 66 question parallel examinations (2e). Results indicated that there was a substantial amount of consistency between the two examinations based upon the same examination weighting. See Appendix B for detail.

Additional research carried out on the method used to administer an examination revealed, in general, that examinees preferred to interact with the computer terminal rather than use the hardcopy format, contrary to expectations.

OBJECTIVE #2 (Cont'd)

It should be clearly noted that this test exercise was conducted to evaluate the consistency with which the computer produces examinations and that all items within this bank were not validated for interprovincial use or according to interprovincial requirements. The only purpose in establishing a bank was to permit the testing of the operational soundness of the computer programs. Testing of the software exposed certain areas of program coding that will require modifications prior to implementation.

If, as the committee recommends later in the report, the item bank were validated, this system can be expected to produce valid interprovincial examinations.

OBJECTIVE #3

To create a data entry and maintenance program allowing candidates from across Canada to be registered and their files edited as required.

In direct interaction with the system, national sub-committee members successfully tested the system by:

(a) having each committee member sign onto the system, as if they were officers from New Brunswick, registering and approving a "candidate" to write an Interprovincial examination;

(b) confirming that "candidates" cannot break system security to write an examination without approval;

(c) confirming that candidates cannot rewrite the same examination version without approval;

(d) making sure the system notifies the responsible officer that a candidate is not eligible to rewrite an examination because three months had not passed between the first and second writing. (If, however, the officer elects he/she may allow the candidate to rewrite an examination within the three month period); and

(e) establishing that officers from across Canada can view all applicant files; however, only the province where the candidate resides is able to edit the file.

OBJECTIVE #4

By electronic means, to be able to score either traditional hard copy format examinations or those administered via computer terminal.

In direct interaction with the system, national sub-committee members successfully tested the system by:

(a) validating that score sheets that had been passed through the optical reader were actually transferred correctly to the computer program, and by validating that candidates who wrote examinations by interacting with the computer terminal were correctly scored by the program; and

(b) validating that the system updates a candidate's transcript of marks.

OBJECTIVE #5

To have a reporting mechanism in the system to create an item analysis, examination analysis, an item tracking procedure, summaries by province and candidate inquiries such as marks, and the place of writing.

National sub-committee members tested the system by having the program conduct item and examination analyses on the two parallel examinations previously mentioned in Objective #2. Attention should be given to the fact that other than the item and examination analyses, the remaining summary and reporting features are not yet programmed. These features can be added at a later date without prejudice to the pilot project.

Hardware and Communication Requirements

Below are equipment requirements, with costs, that are necessary to operate the Interprovincial Computerized Examination Management (ICEM) System.

It should be noted that this list is the requirement or the equivalent of one work station to be used by one person.

Hardware:

(a) HP 150 II complete with dual disc drive OR as a suitable alternative any one of the four IBM's listed below. — $4500.00

*(i) IBM PC XT complete with graphic board and the reflection package

*(ii) IBM PC XT - 286 complete with graphic board and the reflection package

*(iii) IBM PC AT complete with graphic board and the reflection package

(iv) IBM PS2 Model 30 complete with graphic board and the reflection package — $4000.00

(b) HP Laser Jet Series II Printer — $4300.00

(c) X.25 pad with cable — $1860.00

(d) "Sentry 3000" optical reader for marking score sheets for examinations administered in hard copy format — $8000.00

*NOTE: Although these units are no longer being manufactured by IBM, some jurisdictions may have these PCs in operation and, if so, they will support the system.

Communication Costs:

(a) Fee for the initial installation of the data pak line $ 200.00

(b) Monthly rental charge for the data pak lines $ 456.00

(c) Charges for communicating from Fredericton "packets" or packages of information over data pak lines. The cost of these packets, listed below, is priced according to jurisdiction and also by the quantity of packets used, per thousand.

	(Per 1000 Packets)
St. John's Newfoundland	1.67
Halifax, Nova Scotia	1.15
Charlottetown, P.E.I.	2.26
Montreal, Québec	1.44
Toronto, Ontario	1.68
Winnipeg, Manitoba	2.14
Regina, Saskatchewan	2.27
Edmonton, Alberta	2.42
Burnaby, British Columbia	Off-Net
Ottawa, Hull	1.52
Yellowknife, N.W.T.	Newly added Datapac
Whitehorse, Yukon	Services and rates are not yet available

NOTE: In the case of Burnaby, which does not have datapac services, the monthly rental charge for a data pak line would be the on net price to Vancouver ($456.00) plus the off net charge to Burnaby ($205.00) for a total of $661.00 per month.

In order to provide a relationship between cost and packet quantity, one might consider the following example:

It requires approximately 670 to 700 packets to create, print and communicate one master copy of a 130 item examination from Fredericton to any jurisdiction in Canada. The table below outlines the cost to each jurisdiction to perform this activity. Costs were calculated from Fredericton to other jurisdictions simply because of the ease in which the information was gathered.

Communicating from Fredericton To	Cost per Examination
St. John's	$ 1.17
Halifax	$ 0.81
Charlottetown	$ 1.58
Montreal	$ 1.00
Toronto	$ 1.18
Winnipeg	$ 1.50
Regina	$ 1.59
Edmonton	$ 1.69
Burnaby	$ 1.82
Ottawa	$ 1.06
Yellowknife	Costs are unavailable
Whitehorse	for these two jurisdictions

The above prices do not include the monthly rental charge for data pak lines.

Advantages of a Computer System

1. Following the development of an item bank, the turn around time of creating a new examination, using the computer, is shorter than the traditional method of examination construction. A computer generated examination, involving an automatic selection of items, requires no more than ten minutes to create and print a master copy. Even constructing an examination with the assistance of the computer (a manual selection of items), requires only three to four hours. By contrast, the traditional method of constructing an examination takes 18 months, and in some cases 2 years to develop.

2. Using the reporting section of the program, more specifically item statistics, examination construction becomes better organized and places more emphasis on how an item performs as a valid measure of competence, rather than merely whether it appears valid. The items are associated with the on-the-job tasks performed by tradespeople, thus making the validity of examinations criterion-referenced.

3. Although the system was designed primarily for interprovincial use, pre-planning made provisions allowing the system to be used for provincial/ /territorial needs: such as the creation of block examinations at the end of a training period; unit tests if the program is delivered in modular or competency based formats; subject testing; and comprehensive testing when apprentices are required to pass each section of an examination. The program has the capability of determining common content between trades or occupations, which provides an accurate way of granting credits from one trade area to another. Even though programming meets provincial/territorial needs, jurisdictional autonomy remains intact, which is important when considering issues like security. In other words, if a province/territory does or does not want others to have access to their banks, files, etc., then the system will respect their wishes.

4. The repetitive translating and manual validating of items is eliminated with a computer system. Once items have been translated, then, they do not have to be subjected to validation or translation again. Statistical validation

is an ongoing cumulative process provided by the system as it collects information on each individual examination item. Currently both of these processes are a manual operation consuming human resources, time and funds.

5. The overall efficiency of the translation committee would be improved by utilizing this system because it would eliminate intermediate steps between Quebec and CEIC by allowing the direct input and maintenance of items onto the data base, giving provinces instant access to translated items.

6. Officers can utilize the system as a counselling device. If the officer agrees, a candidate, after writing an examination, could view all the questions he/she answered incorrectly, thus enhancing the learning environment. In this instance, the danger of the candidate compromising examination questions does not exist because of the ease with which the program can create new examinations.

7. The time required for examination maintenance is reduced because the host computer makes the changes, and in seconds, these revisions are made available to all jurisdictions.

8. The "Interprovincial Examinations Reports" as compiled by C.E.I.C. are easily created on demand using the reporting segment of the system.

9. The problem of a candidate writing the same examination twice in the same day, writing one in one province/territory, and crossing the border to make a second attempt in another province/territory is easily eliminated through the instant updating of the files by the computer. When a candidate writes an examination, the updated file and security levels within the program will not allow him/her, without approval, to access the program again to write an examination in the same trade.

10. Utilizing the computer, CEIC staff can directly input occupational analysis data which, in effect, is the blueprint or the weighting plan for the interprovincial examination. The questions then are easily linked to the appropriate tasks. This effort results in a true matching of the examination directly to the needs of Canadian industries.

Disadvantages of a Computer System

1. If this computer system were implemented, then Provinces/Territories could receive one master copy of an examination. The cost of mass production could likely become the responsibility of the provinces and territories. Currently CEIC has the responsibility of printing and distributing interprovincial examinations.

2. Up front costs of initially developing item banks are high, but fall rapidly afterward. Long term operation becomes far more cost effective than current manual development.

3. In regards to candidates interacting with the computer to complete an examination, the current graphic capabilities are limited to what and how they are shown.

> Limited to "what" means the inability to produce photograph type illustrations, which are occassionally used in trade examinations. An active search should be conducted to find or at least attempt to find the necessary hardware required to incorporate these kinds of illustrations into the software package.
>
> Limited to "how" refers to the one screened system which currently requires a candidate to toggle from the item to the graphic and back again. Although results of the pilot did not reveal toggling as being a major concern, it might have an effect on a candidate's examination results. Consideration should be given to a two screened system showing the item on one screen and the graphic on the other.

Training Users of The System

Considering that the system consists of several components and each jurisdiction could have from five(5) to twenty (20), or perhaps more employees involved in utilizing this system, then five (5) days of on-site training sessions should be sufficient to train staff from each province/territory. Naturally this will require the assistance of a user's manual, classroom training aids, and hands on practice for the trainees in using the computer. Prior to the instructor arriving on site each jurisdiction would be required to have the hardware connected to the system. For the travel cost of technical staff, the host system can assist in the hook-up of the hardware and in commissioning the software package.

Topics Requiring Discussion by ISEC and ISPCC Members

As a result of conducting the pilot project there are a number of topics that require further discussion and decision by ISEC and/or ISPCC members. The following list is by no means all inclusive and topics such as this should be further studied in detail and become part of the mandate for the "National Steering Committee", referred to in the recommendations of this report.

TOPIC #1: SYSTEM SECURITY LEVELS:

Currently there are four levels of security programmed into the software package: global, manager, trainer, and candidates. The description of these levels are as follows:

Global: One person in Canada, referred to as "GLOBAL", has complete access to the entire system which means; access to all banks provincial or interprovincial; setting up security clearances and passwords for all provincial/territorial Managers; and setting up the numbering sequences used by the system when randomly assigning numbers for registration files, graphic numbers, and the item numbers. It is also intended, for reasons of maintaining control, that this person be attached to the national host computer system.

Manager: One "Manager" from every province/territory will be given security clearance to access the item bank program to include; viewing all interprovincial item banks; authorizing changes to an interprovincial item bank for which his/her province is responsible for; viewing and editing interprovincial candidate registration files originated from the home province/territory but only viewing candidate files from other provinces. Manager will have the responsibility of awarding system security clearances to all staff within his/her own province/territory.

Trainer: With security clearance awarded by the manager, the trainer will have access to all items in all banks. Items accessed by the trainer will have all identifiers removed except the correct response, keywords, and its reference to the task.

Candidate: The manager can provide security clearance to allow candidates complete or no access to all items in a bank to be used as a training aid. Candidates will only be able to view items and not have access to the correct response or any other identifiers.

Issue A involving security levels:

The security levels described above are the security levels for those from outside the interprovincial family who wish, for various reasons, to access items from the bank; however, the system does not have any security levels that restrict interprovincial family members to certain areas of the system. For instance, a director (manager level) would have to give a manpower training officer (field staff) complete access to the system in order for this officer to simply register a person into the IP program. The danger of this, of course, is examination compromise because this officer also has complete access to all questions, examinations, and keys. Others like examination officers, data processors, and secretaries all have the same security level; therefore, it is recommended that internal security levels below "Manager" (Director) be programmed to reflect what is shown in Table #1 following issue B.

Issue B involving security levels

In addition to the lack of internal security levels, there are also concerns with the four security levels already in place (Global, Manager, Trainer, and Candidates).

Currently both trainer and candidate are given security clearance by the manager (director) and they can view all items in all trade areas. Consideration should be given to the idea of the manager giving the trainer clearance to view only the items from the subject area he/she is teaching. And as an added security feature the manager could further clear security for the trainer to authorize candidates to view items from the trade area from which he/she is studying.

TABLE #1

	CEIC STAFF	PERSON MARKING EXAMS	DATA PROCESS FOR EXAMS	SECRETARY TO FIELD STAFF	TRAINING OR FIELD STAFF	EXAMINATION OFFICER	
			X			X	INPUT ITEMS
			X			X	VIEW ITEMS
			X			X	DELETE ITEMS
			X			X	EDIT ITEMS
	X		X			X	INPUT BLUEPRINT
							DELETE BLUEPRINT
	X		X			X	EDIT BLUEPRINT
							DELETE EXAMS
						X	GENERATE AND EDIT EXAMS
				X	X		INPUT DATA FROM CANDIDATE'S REGISTRATION
	X	X	X	X	X	X	VIEW CANDIDATE'S REGISTRATION
		X		X	X		EDIT CANDIDATE'S REGISTRATION
					X		APPROVE CANDIDATE TO WRITE EXAM
		X					MARK EXAM USING OPTICAL READER
	X	X	X			X	VIEW EXAM KEYS
			X			X	INPUT EXAM KEYS
		X	X			X	EDIT EXAM KEYS
	X		X			X	ITEM ANALYSIS
	X		X			X	EXAM ANALYSIS
	X		X			X	ITEM TRACKING PROCEDURE
	X		X	X	X	X	NATIONAL STATISTICS
	X		X	X	X	X	PROVINCIAL STATISTICS
	X		X	X	X	X	SUMMARIES BY SUCCESSES
	X		X	X	X	X	CANDIDATE SUMMARY
		X	X	X	X	X	EXAM BREAKDOWN FOR INDIVIDUAL CANDIDATES
			X	X	X	X	CERTIFICATION HISTORY FOR CANDIDATES

NOTE: By contrast the "Manager" level of security has access to all system components.

Issue C involving security levels:

At the annual ISEC meeting in Vancouver in 1986 members addressed the issue of who should be able to access item banks and to what level of access would be allowed. A recommendation was formulated (See Appendix C) and forwarded to ISPCC for their consideration. A decision has yet to be made on this issue and the time is now for constructing such a policy. The time is now because the item bank project has and is increasingly gaining publicity causing teachers, candidates, other government agencies and at least one other country to inquire about accessing this innovative system.

Although this issue was seemingly well addressed in Vancouver, a recent request has prompted the sub-committee to bring the following unique request to your attention.

> "A request was received, from another training agency, to obtain tapes of the item bank's software or program code for the intended purpose of writing a computer program, enabling them to transfer information from the item bank system to their own computer system.

The question is: "Do the directors wish to give this kind of unlimited electronic access to the item bank, without any control over security, to any one or any agency that requests it?"

This committee recommends that until the system is operational no parts of it should be made available to any agency. As in any project development process, the premature release of content is counterproductive and fosters the growth of misinterpretation.

TOPIC #2: SIZE OF GRAPHICS TO BE USED WITH THE SYSTEM

Graphics supporting the system proved to be a concern. Concerns ranging from the quality of resolution being displayed on the screen to the program's inability to merge text of the item with the graphic when producing a hard copy format. Even though these features were not a requirement of the system specifications, New Brunswick commissioned the University of New Brunswick to undertake a study to research ways of overcoming these difficulties. See Appendix "D" for the contents of this study.

If graphics are to be considered as an enhancement to the system and displayed on the terminal for candidates to refer to when writing an examination; then ISEC has to consider the size of these graphics when developing or revising items for a bank. It is not reasonable to expect a computer terminal, with a 7" x 9" screen, to display, with acceptable resolution, a blueprint that is normally drawn much larger on paper.

It is, therefore, recommended that if this system is to be used for testing purposes that graphics be addressed in depth and regulated in guidelines governing the construction of examinations.

TOPIC #3: VALIDATING ITEMS FOR INCLUSION INTO A BANK

If the validation of items is not carefully planned for inclusion in a computer system, it could have an impact on human resources, budget and the workload of the translation committee. Consider the validation of items for a bank of about 5000 questions. If it were permitted to follow the current procedures of validating items, the time, people, and cost required, would be astronomical. If, however, each jurisdiction would assume the responsibility for validating approximately 500 items and all other jurisdictions would accept their efforts on face value, then human resources or cost would not be greatly affected. To further enhance the validation process this system has checks and balances such as item analysis, examination analysis, and the automatic flagging of items as being "inactive" to help identify items that do not meet the specified criteria supportive of good testing methodology.

Any alternative considered, other than phasing a bank in over a 3 or 4 year period, would place a heavy workload on the translation committee, especially if ISEC or ISPCC choose to develop a bank for more than one trade at a time.

Committee Recommendations

1. That ISPCC accept the report of the sub-committee and confirm the completion of the pilot project along with the sub-committee's mandate.

2. That the ISPCC approve the adoption of the "Interprovincial Computerized Examination Management" (ICEM) System.

3. That ISPCC establish a "National Steering Committee" to move the Interprovincial Computerized Examination Management (ICEM) System from the pilot to the operational stage, and to resolve any related issues created by implementing this system.

4. That ISPCC ensure the provision of continued financial support for maintaining and updating the system.

RAPPORT

DU

SOUS-COMITÉ NATIONAL

PRÉSENTÉ AU

COMITÉ DE COORDINATION DU PROGRAMME DE NORMES INTERPROVINCIALS

SUR LE

SYSTÈME DE GESTION DES EXAMENS INFORMATISÉS INTERPROVINCIAUX

OCTOBRE 1987

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Avant-propos

Le Comité de coordination des programmes de normes interprovinciales, responsable des normes interprovinciales sur les examens, soucieux d'améliorer, de valider et de protéger les épreuves, a recommandé en 1983, qu'un sous-comité étudie la possibilité d'utiliser l'informatique pour contribuer à résoudre les problèmes. Un concept de "banque de questions informatisées" a été élaboré pour les examens interprovinciaux. Au cours des mois suivants, les membres du sous-comité se sont penchés sur l'identification des paramètres d'une banque de questions et sur la préparation d'un rapport sur l'évaluation des coûts d'un projet-pilote.

Ce rapport a été déposé à la réunion des sous-Ministres des provinces et des territoires qui a eu lieu en mars 1984; il contenait essentiellement les recommandations suivantes:

1) l'approbation de la mise sur pied d'un projet-pilote en matière d'évaluation informatisée, et
2) son financement grâce à un budget de 116 000 $.

Ayant reçu l'appui de principe des sous-Ministres, les recommandations du sous-comité ont été inscrites à l'ordre du jour de la réunion du 7 mars 1984 des Ministres des provinces et des territoires. Le projet-pilote sur l'informatisation des examens, doté d'un bujget de 112 000 $, a été approuvé.

Le Comité de coordination des programmes de normes interprovinciales a immédiatement pris des mesures en vue de recommander à la CEIC que le Nouveau-Brunswick soit responsable de l'exécution du projet-pilote sous la direction du sous-comité national sur l'évaluation informatisée. Le 31 janvier 1985, un accord visant la production d'un système d'évaluation informatisé a été conclu entre la province du Nouveau-Brunswick et Emploi et Immigration Canada.

L'expérience prouve que le budget alloué n'était pas suffisant; néanmoins, le Nouveau-Brunswick a continué à appuyer le projet-pilote jusqu'à la fin.

Le présent rapport est le résultat des efforts qu'a déployés le sous-comité national en vue de résoudre les problèmes soulevés par le Comité de coordination des programmes de normes interprovinciales en 1983.

Sous-comité national

Le Sous-comité national est composé de Mal Cook de l'Alberta, de Hans Kotiesen et de Paul Montpetit de l'Ontario, qui représentent à la fois la province et le fédéral (CEIC), d'André Saint-Jean et de Gilles Charbonneau du Québec, ainsi que de Sid Harris et de Richard Ingram du Nouveau-Brunswick.

Remerciements

Comme c'est le cas dans toute entreprise d'envergure, il faut remercier de nombreuses personnes pour leur contribution.

Anciens membres du Comité:

Gordon Booth	CEIC
Brian Carr	Territoires du Nord-Ouest
Howard Hewer	Ontario
Tom Watson	CEIC
Bill Waugh	Nouveau-Brunswick

Codage des questions de la Banque de données:

Al Lessner	Terre-Neuve
Gerry Nelson	Nouvelle-Écosse
Don Stewart	Noveau-Brunswick
Dennis Webster	Île du Prince Édward

Production de graphieques informatiques:

Roger Dupuis	NBCC - Moncton
John Hanusiak	NBCC - Moncton
Donna MacDougall	NBCC - Moncton
Janet Miousse	NBCC - Moncton
John Perrin	Ministère du Travail - Nouveau-Brunswick
Wayne Ritchie	NBCC - Moncton
Betty Trzop	NBCC - Moncton

Recherche des graphiques informatiques:

Jeff Foreman	Université du Nouveau-Brunswick
Évelynn Richard	Université du Nouveau-Brunswick

Informatique:

Crystal Hay	Ministère de l'Enseignement supérieur et de la formation - Nouveau-Brunswick

Programmation:

Tom Buckingham	Ministère de l'Enseignement supérieur et de la formation - Nouveau-Brunswick
Brian Donovan	Ministère de l'Enseignement supérieur et de la formation - Nouveau-Brunswick
Brenda Mulherin	Ministèrer de l'Enseignement supérieur et de la formation - Nouveau-Brunswick

Résumé administratif

Une recherche active, sous la direction du Comité de coordination des programmes de normes interprovinciales (CCPNI), a été entreprise en 1983 en vue d'établir un système qui améliorerait diverses facettes de l'administration et de la création des examens "Sceau rouge". En janvier 1985, Emploi et Immigration Canada a convenu de financer un projet-pilote au Nouveau-Brunswick visant l'élaboration et la mise à l'essai d'un système de gestion des examens informatisés interprovinciaux (GEII). Un sous-comité national du CCNI, composé de l'Alberta, du Nouveau-Brunswick, de l'Ontario et du Québec, a assuré la surveillance de ce projet-pilote.

Un système informatisé a été établi et mis à l'essai au regard des processus importants énumérés ci-dessous:

1. La création d'une banque de questions servant autant pour les examens interprovinciaux que provinciaux, qui permet la saisie, l'édition, l'élimination et l'extraction sélective des items. La capacité de cette banque est pratiquement illimitée.

2. La création informatisée manuelle et automatique d'examen comportant des graphiques et de formes diverses: en anglais et en français, en mesures métriques et impériales, sur support de papier et sur écran. On a aussi vérifié l'équivalence des examens informatisés ainsi que la facilité d'accès pour l'usager des examens sur écran.

3. L'inscription des candidats aux examens interprovinciaux dans des fichiers qui peuvent être consultés à l'échelle du pays pour des fins de mise à jour, de prise de décisions au sujet de l'admissibilité et de production de rapports statistiques.

4. La précision de la correction des examens sur écran et sur papier et la mise à jour des fichiers des candidats.

5. La création d'un programme pour effectuer des analyses d'items statistiques et d'examens, et les autres données qui devront être ajoutées ultérieurement.

Ce rapport identifie en outre un certain nombre de possibilités qui s'offrent aux usagers qui voudraient se joindre au système, et il en donne les coûts; il énumère les avantages et les inconvénients d'un système informatisé, il fait état de la formation des utilisateurs et il décrit dans leurs grandes lignes plusieurs questions devant faire l'objet d'études plus approfondies dans les domaines des niveaux de sécurité du système, des graphiques et de la validation des questions.

En conclusion, le sous-comité national émet une série de recommandations relatives à l'exploitation du système.

Objectifs du système

Le projet-pilote sur le système d'examens informatisés interprovinciaux avait pour but la vérification des objectifs énumérés dans les fiches de spécifications du système datées du 8 février 1985 (révision 1:01) (voir l'annexe A). Ces cinq objectifs et le résultat de leur validation paraissent ci-dessous.

OBJECTIF N° 1:

Créer une banque de questions comprenant un programme de saisi et de mise à jour des données, qui permet aux responsables des examens partout au Canada de saisir, d'éditer et d'éliminer les questions qu'elle contient.

En interaction directe avec le système, les membres du sous-comité ont vérifié ce critère comme suit:

a) ils se sont assurés que les provinces et les territoires étaient en mesure de consulter la banque d'items interprovinciale, mais que seulement la province ou le territoire d'origine pouvait éditer les items;

b) ils se sont assurés qu'une province ne pouvait consulter la banque d'une autre province ni y avoir accès sans autorisation; et

c) ils ont saisi une question l'ont mise à jour et l'ont éliminée.

OBJECTIF N° 2:

Produire de façon automatique (création par ordinateur) et manuelle (création assistée par ordinateur) des examens en anglais ou en français ou les deux, en mesures impériales ou métriques ou les deux, et sur support traditionnel de papier ou sur un terminal d'ordinateur.

En interaction directe avec le système, les membres du sous-comité national ont vérifié ce critère comme suit:

a) ils ont créé manuellement et automatiquement des examens en français, en anglais et dans les deux langues;

b) ils se sont assurés que la disposition des examens produits manuellement était conforme aux exigences des membre du comité;

c) ils ont examiné des cahiers de graphiques automatisés qui accompagnent les questions de la banque afin d'en vérifier la précision et la qualité; et

d) ils ont tenté de sélectionner des items pour les inclure dans un examen produit manuellement même si l'utilisation de ceux-ci dans une épreuve était contre-indiquée.

Afin d'évaluer la qualité des examens produits par le système, on a vérifié ce critère de façon plus approfondie en créant par ordinateur deux épreuves parallèles de 66 questions et en les évaluant dans des situations réelles (2e). Des recherches additionnelles sur la méthode utilisée pour faire passer les examens ont démontré dans l'ensemble que les candidats préféraient se servir d'un terminal d'ordinateur plutôt qu'écrire leurs réponses sur papier, contrairement à ce que l'on aurait pu croire. Les résultats ont montré qu'il y avait beaucoup de cohérence entre les deux examens corrigés avec la même pondération. Voir les détails à l'annexe B.

Il ne faut pas oublier que cet exercice avait pour but d'évaluer la constance avec laquelle l'ordinateur produisait ces examens, et que tous les items de la banque n'étaient pas validés pour une utilisation à l'échelle interprovinciale ni selon les critères interprovinciaux.

Le but de l'établissement d'une banque était d'évaluer l'efficacité opérationnelle du programme informatique. L'évaluation du logiciel a démontré que l'on devra modifier cerains aspects du codage du programme avant sa mise en opération.

Si la banque de questions était validée, comme le recommande le comité ci-après, on s'attend à ce que ce système produise des examens interprovinciaux valides.

OBJECTIF N° 3

Créer un programme de saisie et de mise à jour des données qui permette d'inscrire des candidats de tout le Canada et d'éditer leur fichier au besoin.

En interaction directe avec le système, les membres du sous-comité ont vérifié ce critère comme suit

a) chaque membre s'est inscrit au système comme s'il était du Nouveau-Brunswick; il a ensuite fait l'inscription d'un candidat néo-brunswickois et lui a donné l'autorisation de passer un examen interprovincial;

b) on a permis à des "candidats" de tenter de violer la sécurité du système pour subir un examen sans autorisation;

c) on a permis à des candjdats de tenter de passer une seconde fois la même version d'un examen sans autorisation;

d) on s'est assuré que le système signalait à l'agent responsable qu'un candidat n'était pas admissible à un examen qu'il avait déjà passé parce qu'il ne s'était pas écoulé trois mois entre ses deux tentatives. Toutefois, si l'agent le décidait, il pouvait autoriser le candidat à subir l'examen avant l'échéance de trois mois; et

e) on s'est assuré que tous les agents au Canada pouvaient consulter les fichiers de tous les candidats, et que seule la province de résidence pouvait mettre son fichier à jour.

OBJECTIF N° 4

Pourvoir de façon informatisée corriger les examens sur support traditionnel de papier et ceux qui sont donnés par terminal d'ordinateur.

En interaction directe avec le système, les membres du sous-comité national ont vérifié ce critère comme suit:

(a) ils se sont assurés que la note des feuilles de pointage traitées par le lecteur optique était correctement transmise au programme de l'ordinateur, et que la correction des examens passés par les candidats à l'aide du terminal était effectuée avec précision par le programme; et

(b) ils ont vérifié la mise à jour par le système du bulletin des candidats.

OBJECTIF N° 5

Inclure dans le système un mécanisme de production de rapports en vue de créer une analyse de questions, une analyse d'examens, un procédé de repérage des questions et des résumés par province, de répondre aux demandes des candidats, au sujet des notes entre autres, et d'identifier le lieu où l'examen a été passé.

Les membres du sous-comité national ont mis le système à l'essai en faisant effectuer par le programme une analyse de questions et d'examens portant sur les deux épreuves parallèles décrites dans l'objectif n° 2. Il faut se souvenir que, contrairement aux analyses de questions et d'examens, les mécanismes de production de rapports et de résumés n'ont pas encore été programmés. Ces caractéristiques pourront être ajoutées ultérieurement sans incidence sur les résultats du projet-pilote.

Coût du matériel et des communications

Le matériel requis pour l'exploitation du système de gestion des examens et le coût de celui-ci paraissent ci-dessous.

On doit prendre note que cette liste énumère le matériel nécessaire à l'établissement d'un poste de travail ou de son équivalent.

Matériel

(a)	HP 150 II avec unité de disque double L'un des quatre IBM ci-dessous peut constituer une alternative convenable.		4 500 $
*(i)	IBM PC XT avec tableau graphique et progiciel de réflexion	3 500 $	
*(ii)	IBM PC XT - 286 avec tableau graphique et progiciel de réflexion	4 600 $	
*(iii)	IBM PC AT avec tableau graphique et progiciel de réflexion	8 100 $	
(iv)	IBM PS2 Model 30 avec tableau graphique et progiciel de réflexion		4 000 $
(b)	Imprimante HP Laser Jet Series II		4 300 $
(c)	Bloc X.25 avec câble		1 860 $
(d)	Centry 3000 lecteur optique pour la correction des feuilles de pointage pour examen sur papier		8 000 $

*NOTE: Bien que la compagnie IBM ne fabrique plus ces types d'appareils, certaines provinces continuent de les utiliser; toutefois, les anciens et les nouvaux appareils sont compatibles.

Frais de communication:

(a) Frais d'installation de la ligne Data Pac 200 $

(b) Frais mensuels de location des lignes Data Pac 456 $

(c) Frais de transmission par ligne Data Pac de "paquets" de données de Fredericton. Les coûts de ces paquets, qui sont énumérés ci-dessous, sont établis en fonction des zones et des quantités de paquets transmis, par millier.

	(Par millier de paquets)
Saint-Jean (Terre-Neuve)	1.67
Halifax (Nouvelle-Écosse)	1,15
Charlottetown (Île-du-Prince-Édouard)	2,26
Montréal (Québec)	1,44
Toronto (Ontario)	1,68
Winnipeg (Manitoba)	2,14
Regina (Saskatchewan)	2,27
Edmonton (Alberta)	2,42
Burnaby (Colombie-Britannique)	Hors-réseau
Ottawa-Hull	1,52
Yellowknife (T. N.-O.)	Service Data Pac récemment
Whitehorse (Yukon)	offert; les services et les tarifs ne sont pas encore connus.

NOTE: Dans le cas de Burnaby, qui ne bénéficie pas des services Data Pac, les frais mensuels de location d'une ligne Data Pac seraient la somme du tarif mensuel jusqu'à Vancouver (456 $) et du tarif hors-réseau (205 $), soit 661 $ par mois.

Les coûts d'exploitation ont été calculés de Frédéricton aux autres zones simplement parce que les informations nécessaires étaient disponibles sur place.

On doit prendre en considération ce qui suit afin d'établir un rapport entre les coûts et les quantités de paquets:

Il faut compter 670 à 700 paquets environ pour créer, imprimer et transmettre un exemplaire maître d'un examen de 130 questions de Fredericton à n'importe quelle zonne au Canada. Le tableau ci-dessous indique les coûts de transmission d'un tel examen à chacune des zones.

Transmission de Fredericton à:	**Coût par examen**
Saint-Jean	1,17 $
Halifax	0,81 $
Charlottetown	1,58 $
Montréal	1,00 $
Toronto	1,18 $
Winnipeg	1,50 $
Regina	1,59 $
Edmonton	1,69 $
Burnaby	1,82 $
Ottawa	1,06 $
Yellowknife	Les coûts sont inconnus
Whitehorse	pour ces deux zones

Les prix susmentionnés ne comprennent pas les frais mensuels de location des lignes Data Pac.

Avantages d'un système informatique

1. Le temps consacré à l'élaboration d'un examen à l'aide de l'ordinateur est beaucoup moins que celui que nécessite la méthode traditionnelle. La création et l'impression d'un exemplaire maître d'un examen produit par ordinateur (sélection informatisée des questions) ne prennent pas plus de dix minutes. Même l'élaboration d'un examen assistée par ordinateur (sélection manuelle d'items) n'exige que de trois à quatre heures. Par contre, la rédaction d'un examen selon la méthode traditionnelle nécessite 18 mois et même, dans certains cas, 2 ans; c'est trop long!

2. Si l'on utilise le mécanisme de production de rapport du programme, et plus particulièrement les statistiques sur les items, l'élaboration des examens se fait de façon plus structurée et ne se base pas exclusivement sur la validation à vue. Les items sont associés aux tâches qu'accomplissent réellement les gens du métier, ce qui permet de valider les examens en se reportant davantage à des critères précis.

3. Même si le système a d'abord et avant tout été conçu pour un usage à l'échelle interprovinciale, des dispositions ont été prises au cours des étapes précédant la planification afin de permettre son utilisation pour combler les besoins des provinces et des territoires. Ces besoins comprennent la capacité de créer des examens en bloc à la fin d'une période de formation, des examens partiels si le programme est modulaire ou est axé sur les compétences des candidats, des épreuves portant sur des sujets précis et des évaluations exhaustives des apprentis qui doivent subir chacune des sections d'un examen. Le programme a la capacité de définir le contenu commun à divers métiers ou occupations, fournissant ainsi une méthode précise de transfert des crédits d'un domaine à l'autre. Même si la programmation est destinée

à satisfaire les besoins des provinces et des territoires, l'autonomie de ceux-ci reste intacte un aspect important lorsqu'on envisage des questions comme celle de la sécurité. En d'autres termes, si une province ou un territoire souhaite ou ne souhaite pas permettre l'accès à ses banques, à ses fichiers etc., le système respectera sa décision.

4. Un système informatique élimine la traduction et la validation manuelle répétitives. Une fois que les items ont été traduits, ils n'ont pas à être soumis une nouvelle fois à la traduction et à la vérification. La validation est un processus permanent et cumulatif qui est assuré par le système au fur et à mesure qu'il recueille des données sur chacun des items des examens. Ces deux processus se font actuellement à la main et ils exigent qu'ont y consacre des ressources humaines, du temps et de l'argent.

5. L'efficacité générale du comité de traduction serait améliorée grâce à ce système, car celui-ci éliminerait les étapes intermédiaires entre le Québec et la CEIC en permettant la saisie et la mise à jour directes d'items dans la banque de données et en fournissant aux provinces un accès instantané aux items traduits.

6. Les agents peuvent se servir du système dans le cadre de leurs consultations. Si on y consent, un candidat qui le désire pourrait vérifier toutes les questions auxquelles il n'a pas bien répondu dans un examen, ce qui permettrait de renforcer le processus d'apprentissage. Dans un tel cas, le risque qu'un candidat falsifie les questions d'examen est inexistante à cause de la facilité avec laquelle le programme peut créer de nouvelles épreuves.

7. Le temps requis pour la mise à jour des examens est réduite car l'ordinateur d'origine effectue les modifications et les met à la disposition de toutes les zones en quelques secondes.

8. Les "Rapports d'examens interprovinciaux" compilés par la CEIC sont facilement créés sur demande à l'aide du dispositif de production de rapport du système.

9. Grâce à la mise à jour instantanée des fichiers par l'ordinateur, on élimine le problème que posent les candidats qui tentent de passer le même examen à deux reprises dans la même journée, en en subissant un dans une province ou un territoire et en franchissant la frontière pour en passer un deuxième dans une autre province ou un territoire différent. Lorsqu'un candidat subit un examen, le fichier mis à jour et les niveaux de sécurité du programme ne lui permettent pas d'avoir accès à ce dernier afin de passer un examen dans le même domaine ou d'un niveau identique sans autorisation.

10. À l'aide de l'ordinateur, le personnel de la CEIC peut directement saisir des données d'analyse sur les occupations qui constituent en fait le plan d'ensemble ou de pondération de l'examen interprovincial. Les questions sont ensuite jumelées aux tâches convenables. Ce mécanisme représente une vérification réelle de la corélation entre l'examen et les besoins des industries canadiennes.

Inconvénients du système

1. Si ce système informatique était mis en oeuvre, les provinces et les territoires pourraient recevoir un exemplaire maître d'un examen. Le coût de la production en masse incomberait vraisemblablement aux provinces et aux territoires. Présentement, c'est au CEIC qu'incombe la responsabilité d'imprimer et de distribuer les examen interprovinciaux.

2. Les coûts directs associés à la mise en oeuvre de la banque sont élevés, mais diminuent d'une façon appréciable par la suite. A long terme, ce système est beaucoup moins coûteux que le système non informatisé présentement utilisé.

3. Pour ce qui est du candidat faisant son examen par ordinateur, les capacités graphiques se limitent à ce qu'il voit et à la façon dont il le voit.

"Se limiter à ce qu'il voit" signifie qu'il n'est pas possible de produire de graphiques de type photographique. On procèdera à des recherches actives afin de trouver des solutions pour incorporer ces genre de graphiques à l'assortiement des programmes.

"Se limiter à la façon dont il le voit" fait référence au type d'ordinateur qui ne peut pas reproduire de graphiques; par conséquent, le candidat doit trouver le graphique correspondant à la question, et vice et versa. Bien que cela n'est pas semblé être un problème lors du projet-pilote, cela risque quand même d'avoir un effet négatif sur les résultats du candidat. Nous devrons donc prendre en considération la possibilité d'avoir un système à 2 écrans, soit un pour les questions et un autre pour les graphiques.

Formation des Utilisateurs

Étant donné que ce système est constitué de plusieurs composantes et que chaque zone pourrait employer de cinq (5) à vingt (20) personnes (peut-être même plus) à son exploitation, des sessions de formation sur place d'une durée de cinq (5) jours devraient suffire à entraîner le personnel de chaque province et territoire. Cette formation nécessitera bien sûr un guide de l'utilisateur, du matériel didactique et de la pratique de la part du participant. Avant l'arrivée du moniteur, chaque zone devrait avoir relié le matériel au système. Pour ce qui concerne les frais de déplacement du personnel technique, le Nouveau-Brunswick peut contribuer au branchement du matériel et à la commande du logiciel.

Sujet nécessitant de plus amples discussions entre les membres du CENI et du CCPNI

Certains sujet concernant le projet-pilote, déjà tenu, devront faire l'objet de plus amples discussions, où les membres du CENI et du CCPNI devront prendre des décisions concernant ces sujets. La liste suivante n'est pas complète, et ce type de sujet devrait être vu en détail et faire partie du mandat du Comité national de direction, auquel nous faisons référence dans le présent rapport.

SUJET N° 1: NIVEAU DE SÉCURITÉ DU SYSTÈME

Quatre niveaux de sécurité sont actuellement programmés dans le logiciel: global, administrateur, moniteur et candidat. Voici la description de ces niveaux:

Global: Une personne au Canada, désignée sous l'appellation "GLOBAL", a plein accès à l'ensemble du système, ce qui signifie: l'accès à toutes les banques provinciales et interprovinciales, l'établissement des autorisations de sécurité et des mots de passe pour tous les administrateurs des provinces et des territoires, l'élaboration des séquences numériques qu'emploie le système dans l'attribution au hasard de numéros aux fichiers d'inscription, aux graphiques et aux items. On prévoit aussi que cette personne sera rattachée au système informatique d'origine à l'échelon national pour des raisons de contrôle.

Administrateur: Un "administrateur" dans chaque province et territoire recevra une autorisation de sécurité qui lui permettra d'avoir accès au programme de la banque d'items, ce qui signifie: la consultation de toutes les banques d'items interprovinciales, l'autorisation des modifications apportées à une banque d'items interprovinciale dont sa province est responsable, la consultation et l'édition des fichiers d'inscription interprovinciaux des candidats provenant de sa province ou de son territoire et la simple consultation des fichiers des candidats des autres provinces. L'administrateur aura la responsabilité d'accorder les autorisations de sécurité à tout le personnel de sa province ou de son territoire.

Candidat: L'administrateur peut accorder une autorisation de sécurité aux candidats, laquelle leur permettra ou les empêchera d'avoir un accès complet à tous les items d'une banque utilisée à des fins didactiques. Les candidats ne pourront que consulter les items et n'auront pas accès aux bonnes réponses ni aux autres caractéristiques d'identification.

Moniteur: Grâce à l'autorisation de sécurité que lui accordera l'administrateur, le moniteur aura accès à tous les items de toutes les banques. Les items que pourra consulter le moniteur seront dépouillés de leurs caractéristiques d'identification, sauf de la bonne réponse, des mots-clés et de leur référence à la tâche.

Question A au sujet des niveaux de sécurité

Les niveaux de sécurité susmentionnés sont destinés aux personnes étrangères à la famille interprovinciale qui souhaitent, pour une raison ou pour une autre, avoir accès aux items de la banque; toutefois, le système ne comporte pas de niveaux de sécurité qui restreignent l'accès des membres de la famille interprovinciale à certains domaines. Ainsi, un directeur (niveau de l'administrateur) se verrait dans l'obligation d'accorder à un agent de la formation de la main-d'oeuvre (personnel sur le terrain) l'accès total au système de sorte que ce dernier puisse inscrire une personne au programme PI. De ce fait, les examens pourraient être compromis, parce que cet agent a aussi libre accès à l'ensemble des questions, des épreuves et des touches. D'autres personnes, comme les agents d'évaluation, les opérateurs de traitement de textes et les secrétaires, ont toutes le même niveau de sécurité; il est donc recommandé que des niveaux de sécurité internes sous celui "d'administrateur" (directeur) soient programmés conformément aux indications du tableau 1 à la suite de la question B.

Question B au sujet des niveaux de sécurité

Outre l'absence de niveaux de sécurité internes, il existe des préoccupations quant aux quatres niveaux déjà établis (glogal, administrateur, moniteur et candidat).

À l'heure actuelle, le moniteur et le candidat reçoivent une autorisation de sécurité de l'administrateur (directeur) et ils peuvent consulter tous les items dans tous les domaines d'emploi. On devrait envisager de permettre à l'administrateur d'accorder au moniteur une autorisation ne visant que la consultation des items relatifs à la matière qu'il enseigne. Comme mesure de précaution supplémentaire, l'administrateur pourrait permettre au moniteur d'autoriser les candidats à consulter les items du domaine d'emploi qu'ils étudient.

	6. Personnel du C.E.I.C.	5. Correcteurs	4. Traitement des données pour les examens	3. Secrétaire du personnel de qualification	2. Personnel de formation et de qualification	1. Examinateur
1- Entrée des questions			X			X
2- Graphiques des questions			X			X
3- Effacement des questions			X			X
4- Edition des questions			X			X
5- Entrée des schémas			X			X
6- Effacement des schémas	X		X			X
7- Edition des schémas						
8- Effacement des examens	X		X			X
9- Production et édition des exame						
10- Entrée des données concernant l'inscription d'un candidat						X
11- Edition de l'inscription d'un candidat				X	X	
12- Approbation donnée au candidat faire l'examen	X	X	X	X	X	X
13- Correction de l'examen à l'aide du lecteur optique		X		X	X	
14- Graphique des réponses de l'examen.					X	
15- Entrée des réponses de l'examen		X				
16- Edition des répnoses de l'examen	X	X	X			X
17- Analyse d'une question			X			X
18- Analyse de l'examen	X		X			X
19- Procédure de recherche des questions	X		X			X
20-Statistiques nationales	X		X	X	X	X
21- Statistiques provinciales	X		X	X	X	X
22- Résumé des réussites	X		X	X	X	X
23- Résumé du candidat	X		X	X	X	X
24- Echec de l'examen pour un candidat		X	X	X	X	X
25- Diplôme déjà obtenu par le candidat			X	X	X	X

NOTE: Parcontre, les directeurs de la sécurité ont accès à toutes les composantes

Question C au sujet des niveaux de sécurité

Au cours de la réunion annuelle du CENI à Vancouver en 1986, les membres se sont penchés sur la question à savoir qui devrait avoir accès aux banques d'items et quel niveau d'accès devrait être accordé. Une recommandation a été formulée (voir l'annexe E) et soumise à l'attention du CCPNI. On n'a pas encore pris de décision à ce sujet, et on se doit d'élaborer une telle ligne de conduite dès maintenant, parce que le projet de banque d'items fait l'objet d'une publicité croissante qui entraîne des demandes relatives à l'accès au nouveau système de la part d'enseignants, de candidats, d'autres organismes gouvernementaux et d'au moins un pays étranger.

Même si cette question a apparemment été étudiée à fond à Vancouver, une requête formulée récemment a poussé le sous-comité à soumettre à votre attention la demande unique qui suit:

> "Une demande a été reçue de la part d'un autre organisme de formation qui souhaite obtenir les bandes du logiciel de la banque d'items ou le code du programme dans le but d'élaborer un programme informatique lui permettant de transférer des données du système de la banque d'items à son propre ordinateur."

La question est la suivante: "Les directeurs souhaitent-ils autoriser un accès électronique illimité de ce genre à la banque d'items, sans contrôle de sécurité aucun, à tout organisme qui en fait la demande?"

Le comité recommande qu'aucune partie du système soit mise à la disposition d'un autre organisme avant qu'il ne soit prêt à fonctionner. Comme c'est le cas dans tout processus d'élaboration d'un projet, la diffusion prématurée du contenu n'est pas productive et augmente les risques d'interprétation erronée.

SUJET N° 2: DIMENSION DES GRAPHIQUES DEVANT ETRE UTILISES AVEC LE SYSTEM

Si l'on considère que les graphiques constituent une amélioration au système et si l'on souhaite qu'ils soient affichés au terminal pour le bénéfice des candidats qui subissent un examen, le CENI doit tenir compte de leur dimension dans son élaboration ou sa révision des items de la banque. On ne peut raisonnablement s'attendre à ce qu'un terminal d'ordinateur doté d'un écran de 7 po x 9 po puisse afficher avec une résolution acceptable des plans qui sont normalement tracés à beaucoup plus grande échelle sur papier.

Il est donc recommandé que les graphiques soient étudiés en profondeur et qu'ils soient soumis aux directives sur l'élaboration des examens, si le système doit être utilisé pour des fins d'évaluation.

SUJET N° 3: LA VALIDATION DES ITEMS EN VUE DE LEUR INCLUSION DANS LA BANQUE

Si on ne planifie pas avec soin la validation des items avant leur inclusion dans le système informatique, les ressources humaines, le budget et la charge de travail du comité de traduction risque d'en ressentir les effets. Prenons en exemple la validation d'items d'une banque contenant environ 5 00 questions. Si la méthode actuelle de validation des items était employée, les investissements en termes de temps, de personnes et d'argent seraient astronomiques. Toutefois, si chacune des zones avait la responsabilité de valider environ 500 items et si toutes les autres zones acceptaient d'emblée le travail en resultant, on réaliserait d'importantes

économies du point de vue des ressources humaines et financières. Pour améliorer davantage le processus de validation, ce système est pourvu de mécanismes de vérification et de comparaison comme l'analyse des items, l'analyse des examens et le repérage automatisé des items "inactifs" qui contribue à identifier ceux qui ne sont pas conformes aux critères relatifs à de bonnes méthodes d'évaluation. Le recours à toute méthode autre que la mise en oeuvre graduelle, couvrant une période de 3 à 4 ans, imposerait une lourde charge de travail au comité de traduction, en particulier si le CENI ou le CCPNI désirent élaborer une banque visant plus d'une autre banque à la fois.

Recommandations du comité

1. Le CCPNI accepte le rapport du sous-comité et confirme la réalisation du projet-pilote et le mandat du sous-comité.

2. Que le CCPNI approuve l'adoption du système de gestion des examens informatisés interprovinciaux.

3. Que le CCPNI mette sur pied un "Comité national de direction" responsable de l'exploitation du système et des questions connexes que soulève sa mise en oeuvre.

4. Que le CCPNI assure un soutien financier permanent à la mise à jour et à l'entretien du système.

APPENDIX "A"

INTERPRETATION OF SYSTEM SPECIFICATION SYSTEM SHEET

FOR ITEM BANKING PROJECT

Prepared By

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Report Prepared For the ISPCC Sub-Committee on the
Computerization of Trade Examinations

February 8, 1985
(revision 1:01)

INTRODUCTION

The mandate of the contract stipulates that the Item Banking Project be implemented as a pilot for the Inter-Provincial exams for the Electrical trades. Although New Brunswick has been given the contract to develop the software, the pilot will undergo its final testing by New Brunswick in conjunction with Quebec, Ontario and Alberta. After the project has proved itself, other provinces and territories throughout Canada will be using the system to develop and process Inter-Provincial exams.

Although the project is being developed for Inter-Provincial use, it can very easily accommodate in-province exams as well.

EXPLANATION OF THIS DOCUMENT

The left-hand side of this document contains excerpts of the System Specification Sheet prepared by Gordon Booth of CEIC, Ottawa.

The corresponding right-hand page(s) discusses these points and the implementation team's interpretation of them.

OBJECTIVES

The objectives of the work which is to be performed under the agreement of the contract includes the following areas:

1. An Item Bank

This includes a data entry and maintenance program which will allow examination officers from across Canada to enter and modify (i.e. edit, maintain, or delete) items on an item bank. Items needing revisions can be flaged as such.

We are assuming that the items are multiple choice in format with up to 4 response choices and one correct answer.

Items which require an accompanying diagram or figure will have the reference number of the diagram stored with it.

Key words which specify the items content and define its uniqueness can be entered and modified by an exam officer to be used for referencing and reporting on the item bank.

2. Generation of Exams

Once an item bank containing an adequate number of validated items is in place it will be possible for a computer program to generate any number of unique exams.

It will be possible to produce examinations in either english, french or bilingual and as hard copy or electronically on a computer terminal.

Diagrams and figures will be presented separately in an accompanying booklet. If it is possible, future plans for the item bank include presenting the diagram and figure on the same page as the printed exam or on the terminal if an electronic exam.

We are assuming that exams contain up to 150 items per exam and the exams will be produced according to the criteria specified on the exam prescription sheet prepared by the examination officer.

3. Candidate Registration and Maintenance

This includes a data entry and maintenance program which will allow Inter-Provincial candidates from across Canada to be registered onto the system and once registered, allow maintenance to be performed.

This program will also handle queries by provinces to determine the status and marks of any particular candidate for any examination taken while in Canada.

If we are talking about IP exams, according to National Sataistics there are approximately 15,000 candidates attempting Inter-Provincial exams. As for in-province use we have no feeling for the number of candidates involved. Perhaps individual provinces should be responsible for their own storage of records.

4. Marking Exams

Exams will be produced in one of two formats; hard copy or electronic on a computer terminal. The electronic exams will be marked and the files updated immediately upon completion of the exam. The hard copy exams may be marked by individual provinces or sent to the host computer for marking. If the exams are marked by an individual province, the individual province must forward the score sheets or the equivalent information to the host computer so that it may be used to update the files and be available for analysis and reporting purposes.

5. Statistics and Reports

Item analysis, exam analysis, summaries by province and inquiries/reports by candidate will be provided.

The values for the DV and DI which are stored on the record for each item can be updated by the item analysis program if desired.

SYSTEM SPECIFICATION SHEET

Bilingual Item Bank Creation
- Item Insertion
  - Item Stem
  - Response Options
  - Item Identifiers
    - Pigeonhole Terms
    - Thesaurus Terms
    - Diagram(s)/Figure(s)
  - Item Statistics
- Item Editing
- Item Source
  - Interprovincial Program
  - Provincial Program
    - Trade
      - Module
        - Section

(see system specification sheet, page 2)

Interprovincial Item Bank Update
- Amending Item Parameters (Central Agency)
  - Correct Response
  - Distractors
- Add Key Words

(see system specification sheet, page 4)

1. THE ITEM BANK

1.1 ITEM BANK CONTENT

The Item Banking Project will include a data entry and maintenance program which will allow items to be added, modified and deleted from the system. (See page 8 for who can maintain the Inter-Provincial and in-province item banks.) Information which will be retained on the system for each individual item will include:

UNIQUE ITEM NUMBER
- IP code or Province code
- trade code
- unique number
- version number

EXPLANATION OF THE UNIQUE ITEM NUMBER.
This number is unique for all items on the system. It is made up of either an IP code or province code, where the IP code is used to indicate that the item is for Inter-Provincial use and all provinces can have access to it, and the province code is used to indicate that the item is to be used for in-province use and only the province indicated can access the item. Logically it is as if there are many item banks; one for Inter-Provincial use plus additional banks for each individual province.

The trade code indicates the trade for which the item applies.

The unique number starts at one for every trade and is incremented by one for each item in the trade.

Due to revisions and maintenance of the item bank it may be necessary to modify an item. The change may be significant causing the item to change in context or meaning. If this is the case, a new item is created and identified by the original IP Code or Province Code, original trade code, original unique item number and a new version number. It must be understood that items cannot be changed at will since it will have an adverse effect on the statistical analysis where candidate responses to the SAME item are compared.

When an exam is created, this UNIQUE ITEM NUMBER is retained so that it may be used to reference the item description in the bank.

We will have to decide who can change the information in the item bank and what information can be changed before a new version of the item must be produced.

SYSTEM SPECIFICATION SHEET

Statistical Report Generations
    Item Bank Statistical Summary
        Number of Items
        Item History
            Date Item Stem Generated
            Source Reference [Title, Edition, Date]
                Standard Code [e.g. CSA C22.1-1982]
                Section [e.g. 00]
                    Rule [e.g. 00-0000]
                        Subrule [e.g. 00-0000 (1)]
                            Paragraph [e.g. 00-0000 (1)(a)]
                                Subparagraph [e.g. 00-0000 (1)(a)(i)]
                                    Clause [e.g. 00-0000 (1)(a)(i)(A)]

(see system specification sheet, page 5)

Addition of new items to the item bank must not allow duplicate items to be added. It is not possible to compare an item content against other items on the bank electronically. The procedure for determining the simularity of items might be as follows: determine the key words of the new item and requesting a list of all items on the bank with the same key words and compare the items manually. An alternative to key words is the classification of an item by trade, level, task and category.

ITEM IDENTIFIER
IP code or provincial code
trade code
module/skill
task/sub-skill
caterization of like items

EXPLANATION OF ITEM IDENTIFIER
This identifies the type of program the item belongs to, i.e., Inter-Provincial or in-province, the trade, skill and sub-skill. There may be many items in the bank with the same identifier, this identifier is used when the program randomly selects items from the bank for an exam.

TRADE CLUSTER

MAJOR AREA OF COMPETENCY

ITEM STEM/RESPONSE ITEMS
English version
French version

EXPLANATION OF ITEM STEM/RESPONSE OPTIONS
The English and French versions of the item must be entered simultaneously for Inter-Provincial use. In-province items can be either English, French or Bilingual according to each province's preference.

INDICATION OF CORRECT RESPONSE

DIAGRAM OR FIGURE #

SYSTEM SPECIFICATION SHEET

Date Item Incorporated into Item Bank
Date Item Authorized for Use

(see system specification sheet, page 6)

ITEM STATISTICS

Difficulty value for correct response
Discriminatory index for correct response

EXPLANATION OF ITEM STATISTICS:
These statistical values will be used when generating exams to determine how difficult or how easy an item is. These values will be updated periodically by analysing the responses from the accumulated examinations. These values will be used from analysis of exams at the journeymen level.

We will have to decide what to do when initially starting the system when no stats are available on the items. DV/DI use an average value on all items which will be indicated with an *. This necessitates a duality in the generation of exams

1) Allow items to be chosen regardless of the DV/DI values useful at the beginning when items have no valid statistics.

2) Use DV/DI values according to the difficulty formula in the selection of items.

3) Combine both the selection of items having no DV/DI values (indicated when * and no indication of difficulty level) with selection of item according to difficulty formula. An alternative is to code untested items with LOW, MEDIUM, HARD ranges of 25-45, 46-65, 66-95 as opposed to using an * which has no indication of difficulty level. The generation of exams can then be based on selection of items according to the estimated difficulty ranges. It was agreed to use this method of implementing difficulty values on untested items.

THESAURUS OR KEYWORDS

English version
French version

EXPLANATION OF THESAURUS:
The thesaurus or keyword is a method by which an item can be identified through a word or group of words indicating the nature or uniqueness of the item. The system can allow all words found in the item stem and correct response to be entered as key words. It can also allow the entry of special groups of words; not necessarily found in the item description; to be used as key words.

Key words can be used to report on the item bank.

TYPE OF EXAM ITEM WAS TAKEN FROM

REFERENCE

Reference of title and author of text that item text or item content was derived from so that the content of the item may be verified. (50 characters/optional).

EXPLANATION OF REFERENCE

It was suggested in the system specification sheet that the reference include such items as 'STANDARD CODE', 'SECTION', 'RULE', 'SUB-RULE', etc. and although it is not included here we would like to discuss whether it is necessary.

TAXONOMY

EXPLANATION OF TAXONOMY

This indicates what type of knowledge the item is testing, i.e. recall, application, and higher level. This may be considered as a key word and may be used for reporting on the bank.

CODE

EXPLANATION OF CODE

This is used if the item deals with the Canadian or Provincial Code Books. It would include the province, year, and indication if it is a local, provincial or national code, as well as CODE, SECTION, RULE, SUB-RULE, PARAGRAPH, SUB-PARAGRAPH, and CLAUSE. This may be considered a key word and used for reporting on the bank.

Only those items which have a national code will be used for Inter-Provincial exams.

DATE ENTERED ON TO BANK

DATE BEGAN ACTIVE USE

DATE REMOVED FROM USE

EXPLANATION OF DATE REMOVED FROM USE

The item remains in the bank for the purpose of doing statistical analysis and also for reconstruction of an exam but because it is either outdated or a non-effective item, it is no longer used on new exams after this date.

STATUS OF ITEM

EXPLANATION OF STATUS OF ITEM

An item on the item bank could be currently ACTIVE, INACTIVE, ON HOLD, or EXPERIMENTAL. The items marked as INACTIVE, ON HOLD and EXPERIMENTAL would not be included on an exam.

ITEM RESPONSIBILITY

EXPLANATION OF ITEM RESPONSIBILITY
This is used by the Inter-Provincial items to indicate which province contributed the item to the bank.

OF TIMES USED /LAST DATE USED

EXPLANATION OF # TIMES USED/LAST DATE USED
These two pieces of information will be used to aid in the randomness production of exams and can also be used for reporting to indicate the amount of use an item is receiving.

SYSTEM SPECIFICATION SHEET

Item Security
- Interprovincial Materials
  - Universal Access
- Provincial Materials
  - Restricted Access

(see system specification sheet, page 2)

Interprovincial Item Bank Maintenance
- Amending Item Content
  - Access Authorization
    - Levels of Access
      - Project Secretariate (Level One)
        - Review Item Statistics
        - Conduct Statistical Updates
        - Generate Hard Copy Examination(s)
      - Senior Examination Officer (Level Two)
        - Review Item Content
        - Review Item Statistics
        - Generate Hard Copy Examination(s)
        - Item Submission
      - Examination Officer (Level Three)
        - Review Item Content
        - Generate Examination(s) Electronically
        - Generate Hard Copy Examination(s)
        - Distribute Hard Copy Examination(s)
      - Invigilator (Level Four)
        - Generate Examination(s) Electronically

(see system specification sheet, page 5)

1.2 KEY WORDS

Key words are a word or a group of words which identify the nature or content of an item. They can include every word appearing in the text of the item stem and responses as well as additional specific descriptions.

The number of keywords to be provided will have to be decided upon.

Once defined, the key words will be sorted and compiled into a type of dictionary to be used for item bank reporting and management.

Reporting on the item bank through the use of key words can be any degree from general to very specific with the use of the operators 'OR', 'AND' and 'NOT'.

For example you can report on "COPPER AND PIPES" to retrieve all items containing both the key words 'COPPER' and 'PIPE'.

Or you can specify those items containing non-copper pipes by using the command 'PIPES NOT COPPER'.

A third command 'PIPES AND (COPPER OR PLASTIC)' will retrieve all items containing both 'PIPES' and 'COPPER' plus all items containing both 'PIPES' and 'PLASTIC'.

Examination officers will find keywords useful for obtaining listings of specific types of items for doing item bank maintenance, and for retrieving items that are common for associated trades.

Key words are not intended to be used in the random method of generating exams. However, other types of tests such as pre-test, reviews, and upgrading which are intended to cover a specific topic can be randomly generated using Key words.

1.3 ITEM BANK SECURITY

Inter-provincial Use of the Item Bank

Since all provinces across Canada will be contributing to and sharing the Inter-Provincial item bank, some guidelines as to the use and maintenance of the bank must be provided.

All provinces will be permitted to view and report on any item in the Inter-Provincial bank.

Since new items and changes to existing items must first be validated and approved by the Inter-Provincial committee, the Inter-Provincial committee will have the sole responsibility of adding, modifying, and deleting items.

The Inter-Provincial Committee will also be responsible for updating the difficulty value and discriminatory index for the items on the bank.

Each individual province will be permitted to generate their own Inter-Provincial examinations from an established weighting plan.

In-Province Use of the Item Bank

If a province chooses to use the item banking system for the purpose of generating in-province examinations, the items will be coded with the respective province's province code. These items can be accessed and modified solely by that province. Examinations can be generated when desired by the owner province.

A flag will be set to indicate whether the owner province wishes to allow other provinces to view its item bank.

Trainees access to item bank is limited to the in-province item bank and the decision to allow trainees to do so is up to each individual province.

Destruction of Printed Material

Any exams and hard copy listings of items should be destroyed when no longer used.

SYSTEM SPECIFICATION SHEET

Examination Booklet Production (Multiple Use)
- Examination Planning Sheet
  - Specimen Examination(s)
  - Electronic Item Selection
    - Random Choice Method
      - Retain Record of Items Selected
      - Retain Record of Item Sequence
    - Fixed Choice Method
      - Retain Record of Items Selected
      - Retain Record of Item Sequence
  - Printing Examination Booklets
    - Retain Record of Quantity Printed
    - Retain Distribution Record
      - Life Expectancy
      - Destruction Procedure

(see system specification sheet, page 2)

Examination Booklet Production (Single Use)
- Examination Planning Sheet
  - Specimen Examination(s)
  - Electronic Item Selection
    - Random Choice Method
      - Retain Record of Items Selected
      - Retain Record of Item Sequence
    - Fixed Choice Method
      - Retain Record of Items Selected
      - Retain Record of Items Sequence
  - Printing Examination Booklet
    - Retain Distribution Record
      - Life Expectancy
      - Destruction Procedure

(see system specification sheet, page 3)

Examination Diagram(s)/Figure(s)
- Hard Copy Format
  - Retain Record Quantity Produced
  - Retain Distribution Record
    - Life Expectancy
    - Destruction Procedure
  - Electronic Copy Format
    - Life Expectancy
    - Destruction Procedure

(see system specification sheet, page 3)

2. EXAM GENERATION

2.1 PRESENTATION

The main purpose of the item bank system is to generate good quality exams quickly and efficiently. Exams may be requested from anywhere in Canada by mail, phone, electronic mail, a candidate sitting at a terminal or an exam officer sitting at a terminal. Two methods of producing the requested exam will be made available.

Manual Generation of Exams

Generating exams manually can be done with or without using the prescribed weighting plan. If the weighting plan is used, the program will display a series of like items for each trade area and prompt the officer to indicate which of the items should be included on the exam. When the weighting plan is not used, the program will display all items for the specified trade and allow the officer to pick items without regard to trade coverage or difficulty.

Structured Random Generation of Exams

This method of producing exams uses a weighting plan applied to the trade content which indicates the areas from which items should be chosen as well as the number of items required. Also considered when choosing items is the difficulty value associated with the item. Items on an exam must fall into specific difficulty ranges which would ensure that all randomly produced exams are of equal levels of difficulty. The requirements for the difficulty ranges may vary with time or from exam to exam, therefore the systems table of difficulty ranges will have the flexibility to be changed and updated.

Items on a randomly generated exam will be sequenced by BAND, MODULE and TASK. Sequencing within the TASK, MODULE or BAND according to the relationship of one item to another will not be done. Items which relate to other items will have to be re-written or weeded out of the bank.

When the program is choosing items to be included on an exam it must consider the items correct response as it relates to the remaining responses so that it will not be possible for the candidate to build up or determine a sequence of corrct responses.

2.2 LANGUAGE OF EXAMINATIONS

The Examination Officer or candidate can specify the language(s) desired from a choice of English, French or Bilingual. For hard copy Bilingual exams the French version will appear on the left hand side of the booklet while the English is on the right. An alternative is all items in English with the French version underneath and both displayed on the right hand side of the booklet.

Since a computer terminal is limited in the amount of information that can be displayed at one time, it is unlikely that both the English and French versions of the item can be viewed on a single screen. As an alternative, two function keys on the terminal can be provided - one labelled ENGLISH, the other FRENCH, to allow the examinee to switch from the english version to the french version and back again by pressing one key on the terminal.

2.3 GRAPHICS

At this time the question of graphics for the presentation of the figures and diagrams in exam items has not been settled. Until we can find a better method, we will produce a hard copy booklet of diagrams and figures by trade which will accompany the examination or the computer terminal. The examination item will make reference to the appropriate diagram or figure. In the future we hope to be able to integrate the graphics (which are stored in a separate data base from the item bank) with the corresponding item when it is displayed on the terminal or in hard copy exam.

2.4 CONTENT OF EXAM KEYS STORED ON THE SYSTEM

UNIQUE EXAM IDENTIFIER
- IP or province code
- trade code
- level
- version number

NUMBER OF ITEMS ON EXAM

EXPLANATION OF NUMBER OF ITEMS ON EXAM
We are assuming from the system specifications that there are a maximum of 150 items on an exam.

UNIQUE ITEM NUMBER
- IP code or province code
- trade code
- unique number
- version number

EXPLANATION OF UNIQUE ITEM NUMBER
When an exam is generated it would be wasteful of storage and operator time to include the item stem and responses on the exam key. Instead only the unique item number, which is used as an index to the item text in the bank, is retained. This ensures that when an exam is produced the item text will always be current and up-to-date.

CORRECT RESPONSE

EXPLANATION OF CORRECT RESPONSE
This is the correct response which is either A, B, C, OR D; corresponding to the item referenced by the unique item number. The correct response which originates on the item bank is stored as part of the exam key to facilitate faster marking of exams.

CUT OFF MARK OR PASSMARK

EXPLANATION OF CUT OFF MARK
This is the minimum mark which the candidate must attain in order to pass the exam. For Inter-Provincial exams the passmark is always 70%. However in-province passmarks may vary and this field will help make it possible for individual provincial use of the item bank.

PRACTICAL POINTS/TYPE OF CALCULATION

EXPLANATION OF PRACTICAL POINTS/TYPE OF CALCULATION
This field is not necessary for Inter-Provincial exams since a practical evaluation is not required. Some provincial exams require practical evaluations and this field contains the maximum number of practical points available. The type of calculation allows the PASS/FAIL status of the candidate to be determined in one of two ways: 1) the average of the theory and practical marks is used 2) the theory and practical marks are used individually.

SYSTEM SPECIFICATION SHEET

Pre-experimentation Phase
- Date Item Pre-experimented
- Place(s) Item Pre-experimented
  - Number of Candidates
  - Responses Generated
  - Popularity of Each Response
- Date Item Assembled
- Date Assembled Item Validated

This need not be incorporated in the Item Banking System. This is a manual process of having students contribute their spontaneous responses to an item stem.

(see system specification sheet, page 6)

Experimentation Phase
- Date of Experimentation
- Place(s) of Experimentation
  - Number of Candidates
  - Type of Candidate Examined
- Provisional Item Statistics
  - Index of Difficulty
  - Index of Discrimination

(see system specification sheet, page 6)

DATE EXAM IS TO START ACTIVE USE

DATE REMOVED FROM ACTIVE USE

EXPLANATION OF DATE REMOVED FROM ACTIVE USE
If an exam becomes out dated, it may remain on the bank for use in breakdowns and analysis but it should no longer be used for examining candidates. The program will not present an exam after it has been removed from active use. After the required retention period inactive exams may be deleted.

LIFE EXPECTANCY OF EXAM

EXPLANATION OF LIFE EXPECTANCY OF EXAM
On each page of the exam booklet use this field to display the date after which the exam is no longer valid.

DESTRUCTION PROCEDURE

This is a policy statement and need not be incorporated into the system.

ITEMS CONTAINING 2 CORRECT RESPONSES

EXPLANATION OF ITEMS CONTAINING 2 CORRECT RESPONSES
If an item on an exam has two corect responses, both the question number and the two responses are recorded here. When the exam is marked, the candidate's response is compared against the two correct responses.

UNUSED ITEMS

EXPLANATION OF UNUSED ITEMS
If an item on an exam is invalid, is misleading or has no correct response, the question number is recorded here. When the exam is marked, the unused questions will always be marked as correct.

2.5 MAINTENANCE OF EXAMS

A data entry and maintenance program will be provided to allow exams to be entered on to the system and to be edited, modified, and deleted as required. Also new items can be added and old items deleted from exams.

Each time an exam is modified it may be necessary to create a new exam key with the same trade and level but a new version number. The exception to this may be if the exam was not previously used. It is important to keep exams intact over time for the purposes of analysis. Exam keys may be deleted only if they have been removed from active use and the retention period is up; or if no exams have been written for that key.

2.6 TYPES OF EXAMS

Specimen exams are used to demonstrate each of the different types of items available on the system. The items do not need to relate to the trade in question. This is very similar to the practice items given at the start of all exams. It may be difficult for a program to choose one of each type of item, implying the specimen exam should be produced by hand and stored on the system for multiple usage. Like all other exams the specimen exam can be in English, French or Bilingual.

Inter-Provincial exams are generated to meet a required degree of difficulty and to cover all major trade areas according to a validated weighting plan. The items are taken from the portion of the item bank designated for Inter-Provincial use.

Provincial exams are generated according to the needs of the individual province and the items are taken from the portion of the bank designated for that province's use. Additional comprehensive exams can be generated as requested by an instructor or an examination officer through key words to cover a specific trade area. This may be helpful in testing candidates completing an upgrading course. The authority for the instructor to request exams will be determined by each individual province.

Pre-tests or review tests can be generated by a candidate to be used as a learning and review aid. In this case, some guidelines must be prepared to prevent over and invalid use of the system. Perhaps we should stipulate that no more than 30 items be shown and that no hardcopy can be produced.

Pre-experimentation and experimentation exams are mentioned in the system specification sheets as a method of testing the validity of new items. Although it is necessary to test new items we do not believe that this is the type of method to use. It is not fair to allow a candidate to write an exam assuming that all items carry equal value when some items are not a part of the actual exam and will not even be marked. With candidates permission they are given a separate test of 10 to 15 experimental items. The benefit is to derive the DV and DI stats for the item. No extra points will be given for a correct response to an experimental item.

SYSTEM SPECIFICATION SHEET

Client Data Capture
- Client's Name
- Client's Social Insurance Number
- Client's Permanent Address
  - Date of Last Attempt
  - Examining Province
  - Examining Center
  - Trade Examination Taken
  - Class of Examination
  - Items Administered
  - Invigilator's Name
  - Criterion Mark Expected (Cut-Off Score)
  - Mark Attained
    - Letter/Notice of Success
      - Date Certificate Issued
      - Interprovincial Number assigned
    - Letter/Notice of Failure
      - Date Rewrite Permitted
    - Client Status Level
      - Completed Apprentice
      - Completing Apprentice
      - Certificate of Qualification Holder
        - Years of Experience
      - Certificate of Qualification Writer

(see system specification sheet, page 4 & 5)

2.7 EXAM USAGE

Since statistical reports on the usage of exams regarding the number of times used and where used are desired, the following information will be retained for each exam printed

UNIQUE EXAM NUMBER
- IP or province code
- trade code
- level
- version number

NUMBER OF COPIES PRINTED
- EXPLANATION OF NUMBER OF COPIES PRINTED
  - How to control this?

WHERE EXAM IS USED

DATE EXAM IS USED

EFFECTIVE DATES OF EXAM

NUMBER CANDIDATES WRITING

TYPE OF CANDIDATE WRITING

The item banking system can produce multiple copies of the same exam or it can produce multiple unique exams. If unique exams were always produced then each exam key on the system would have only one copy, one destination and one user and thus, the above information would not be necessary.

2.8 EXAM SECTION TITLES

Item analysis and exam breakdowns which list item numbers in a tabular format can be made more meaningful if, when a new section of the exam begins, the corresponding exam section title were printed. This can be provided if the following information is stored.

UNIQUE EXAM NUMBER

SECTION NUMBER

FROM QUESTION NUMBER

TO QUESTION NUMBER

SECTION TITLE

With randomly generated exams the section titles can be prepared automatically at the same time the computer generates the exam, while with manualy prepared exams the titles must be entered by hand.

3. MAINTENANCE OF CANDIDATES

3.1 CANDIDATE FILE CONTENT

A program to register and maintain item bank candidates will allow examination officers from across Canada to register and to make inquiries on candidates. Candidates must be registered on the system prior to them writing an exam (electronically) or having their exams marked. The information to be retained on a candidate's record include the following:

REGISTRATION NUMBER

EXPLANATION OF REGISTRATION NUMBER
It is necessary to uniquely identify each candidate on the system and since it would be abusing the Social Insurance Number to use it for this purpose, a unique registration number assigned by the system will be used instead.

SOCIAL INSURANCE NUMBER

NAME

ADDRESS - City, Postal Code, Phone Number, Province

INDICATION OF PROGRAM IN (either IP or in-province)

GENDER

This is the tombstone information applicable to an IP candidate and is only the one of a kind type of personal information.

We should clarify who can do the maintenance on candidates, i.e. should candidates be modified only by originating province, only by the host province or by any province?

SYSTEM SPECIFICATION SHEET

Client Data Access Limits
- Level One
  - Global Client Statistics (National)
- Level Two
  - Specific Client Statistics (by jurisdiction)
  - Individual Client Records
- Level Three
  - Individual Client Record

(see system specification sheet, page 5)

3.2 CANDIDATE EXAMINATION INFORMATION

For each exam the candidate writes, the following information will be retained:

TRADE

PROVINCE GRANTING CERTIFICATION

CQ DATE

PROVINCE COMPLETING

COMPLETION DATE

PROVINCE WHERE EXAM IS BEING WRITTEN

EXAMINATION CENTER (Optional)

INVIGILATOR (Optional)

EXAM DATE

TYPE OF EXAM (HARDCOPY/ELECTRONIC)

LANGUAGE OF EXAM

CUTOFF MARK OR PASSMARK

MARK ATTAINED

UNIQUE ITEM NUMBERS & CANDIDATE RESPONSES

REASON FOR IP NUMBER NOT BEING ISSUED

EXPLANATION OF REASON FOR IP NUMBER NOT BEING ISSUED
An IP candidate can pass the exam but not be issued a number until other requirements have been completed.

IP SEAL ISSUE DATE

IP SEAL NUMBER

INTER-PROVINCIAL LEVEL OF CANDIDATE

YEARS OF C.Q. EXPERIENCE if IP candidate is attempting Inter-Provincial exam through level CQ holder because of having required years of experience.

NOTE: At the present time the frequency of writing IP exams is once every three months. The purpose of this is to try to maintain the integrity of the exam. This may no longer be necessary since new exams can be used with each writing.

SYSTEM SPECIFICATION SHEET

Examination Scoring Procedures
Electronic Mode (Keyboard)
Hard Copy Mode (Answer Sheet)

(see system specification sheet, page 3)

3.3 SECURITY OF CANDIDATE'S FILES FOR INTER-PROVINCIAL USE

Inter-Provincial Use

It is necessary for all provinces to access the Inter-Provincial candate records in order to verify an application and to determine if and when a candidate had previously written an Inter-Provincial exam.

It will be possible for all provinces to view any record on the system however, updating of the candidates' personal records will be performed solely by the province where the candidate originates or is now a resident.

Updating of marks will be performed by the host computer.

In-Province Use

If a province chooses to use the item bank for producing exams for in-province use, that province will be responsible for registering and maintaining its own candidates. Other provinces will have no access to these candidates.

4. EXAM MARKING

When an exam is generated an exam key containing the unique item number and the correct response is prepared and stored on the system. This exam key is used to index the item bank to retrieve the item text when printing a hard copy exam or displaying the exam on a terminal. It is also used when marking the exams since it contains the correct responses.

Hardcopy Exams

It is assumed that hard copy exams will be responded to using optically read score sheets, although it is not necessary. Individual provinces may wish to mark their own exams thus implying that exams must be written on the medium that the individual province is capable of working with.

All examinations (regardless of them being marked by the individual province) must also be marked and processed by the host computer. This is necessary so that candidate files may be updated and responses for use in analysis be accumulated.

Provinces use various methods of collecting candidates' exam responses and in an attempt to be flexible and not cause the provinces any undue grief we hope to provide the capability of accepting exams on 3-M optical score sheets, National Computer System Optical score-sheets, electronic data tapes, electronically transmitted exam responses, and also keyboard entry.

Electronic Exams

When writing an electronic exam, the examination items are displayed on the screen. A candidate may leave items unanswered and return to them later as with hardcopy exams. Items may also be flaged by the candidate for review so that the system can automatically display the flaged items. The exams will be marked and the records updated after the candidate has indicated the exam is completed.

We will have to spend some time discussing with technical experts how to provide the facility of sending electronic exams across Canada.

We should also discuss the regulations regarding time limit, the displaying of marks, etc. of writing an electronic exam.

The time limit has traditionally been 3 hours for hard copy exams. Electronic exams may take longer and the exam should not be automatically terminated after the 3 hour time limit.The time limit will be decided by the sub-committee and for Inter-Provincial exams the mark will be displayed on the screen upon completion of the exam. For in-province use a flag will be provided to allow each province to indicate if the mark is to be displayed.

The marking program can produce form letters indicating success or failure of the exam and result sheets for all candidates writing an exam either as hard copy or electronic mode.

SYSTEM SPECIFICATION SHEET

- Examination Analysis Procedures
  - Computation of Item Statistics
    - Item Number
      - Response Options
        - Number of Attempts
        - Number of Omissions
        - Correct Response
        - Number Correct
        - Percent Correct Response
      - Item Parameter Computation
        - Difficulty Index
          - Correct Response
        - Discrimination Indices
          - Correct Response
            - Upper-Lower Method
            - Biserial Correlation Method
            - Point Biserial Method
            - Phi Coefficient Method
          - Distractors
            - Upper-Lower Method
            - Biserial Correlation Method
            - Point Biserial Method
            - Phi Coefficient Method
    - Display Results
      - Tabular Format
        - Item by Candidate
      - Graphic Format
        - Frequency Program
        - Histogram

(see system specifications sheet, page 4)

5. STATISTICAL REPORT AND SUMMARIES

The following statistical reports and summaries were listed in the system specification sheet as being required of the system. It appears that all the data required to produce these reports will be stored on the system, and that all we require from the committee is an example of the report format and content. All statistical formulas will be taken from a general purpose statistical text such as the one by Mendenhall @ 1975 by Wadsworth Publishing Company Inc. unless otherwise requested by the Sub-Committee.

5.1 ITEM ANALYSIS

Calculate number of attempts/omissions/correct/Percent Correct
Calculate the DI for all response options
Calculate the DV for all response options using the
upper-lower method
Biserial correlation
Point Biserial
Phi Coefficient
Format should be tabular by item for statistical calculations
should be graphical for frequency of raw marks
(updating of item bank stats should be done when requested, if requested by the Item Bank Sub-Committee.)

The item analysis program will have a menu of available options. These include various types of statistics as well as the option of printing only those items which are considered to be of poor quality. The program will flag poor items to indicate if:

1. an equal number of candidates choosing the correct response and one other response
2. very few candidates choose the correct response while many choose one common mislead
3. there are no attempts to any of the misleads
4. the Discriminatory index is negative for the correct response
5. the Discriminatory index is positive for any of the misleads
6. the Discriminatory index is outside the range 15 to 85.

When an item analysis is requested items which have been used fewer than 30 times will not be considered.

SYSTEM SPECIFICATION SHEET

Provisional Fixed Length Examination Statistics
- Mean (Average)
- Variance
- Standard Deviation
- Standard Error of the Mean
- Mean Deviation
- Median
- Mode
- Maximum
- Minimum
- Range
- Reliability
  - Split-half KR-20
  - KR-21

Item Tracking Procedure
- Chi-Square Technique

(see system specification sheet, page 6)

National Statistical Summary
- Interprovincial Trades Examined
- Candidate Status Prior to Examination
- Candidates' Province of Residence
- Number of Candidates Attempting Examination
- Number of Candidates Succeeding
- Number of Red Seals Issued
- Cumulative Totals

(see system specification sheet, page 7)

5.2 FIXED LENGTH EXAM STATISTICS
(also known as exam analysis)

Calculate the mean
variance
standard deviation
standard error
mean deviation
median
mode
maximum (high score)
minimum (low score)
range
reliability KR-20
reliability KR-21
reliability
raw scores

Format should be tabular for statistics
should be frequency polygram and histogram for raw scores.
A menu will allow the examination officers to select the type and number of statistics to be included in the analysis.

5.3 ITEM TRACKING PROCEDURE

Calculated using the Chi-Square technique

5.4 NATIONAL STATISTICS SUMMARY
(report on IP trades by level of candidate by Province)

Calculate the number of candidates writing the exam
candidates who were successful (number & percentage)

IP red seals issued for the period reporting
the totals by trade and province.

Format should be tabular.

SYSTEM SPECIFICATION SHEET

Statistical Summary by Candidate Status
- Candidates' Province of Residence
- Interprovincial Trades Examined
- Number of Candidates Attempting Examination
- Number of Candidates Succeeding
- Number of Red Seals Issued
- Cumulative Totals

Provinical Statistical Summary
- Interprovincial Trades Examined
- Candidate Status Prior to Examination
- Number of Candidates Attempting Examination
- Number of Candidates Succeeding
- Number of Red Seals Issued
- Cumulative Totals

Statistical Summary by Successes
- Number of Candidates Attempting by:
  - Province
  - Trade
  - Candidate Status
- Number of Red Seals Issued by:
  - Province
  - Trade
  - Candidate Status

Statistical Summary of Client Records
- Examination History
  - Date(s) of Examination(s)
  - Location(s) of Examination(s)
  - Trade(s) Examined
  - Record of Marks
- Certification History
  - Certification(s) Issued
  - Date(s) of Certification

(see system specification sheet, page 7)

5.5 PROVINCIAL STATISTICS SUMMARY
(report on IP trades by level of candidate)

Calculate the number of candidates writing
the number of candidates successful
the number of IP red seals issued
the totals by trade and type of candidate.

5.6 STATISTICAL SUMMARY BY SUCCESSES
(number of attempts by trade, province and status)

Calculate the number of IP red seals issued for
trade,
provinde
type of candidate.
Format tabular.

5.7 CANDIDATE SUMMARIES
(examination history)

Display candidate name
exam date
exam location
exam trade
exam mark

5.8 CERTIFICATION HISTORY

Display candidate name
IP certification date
IP Red Seal number
Trade

5.9 EXAM BREAKDOWN

Calculate for candidate
or trade
or school
or province.

6. PROPOSAL

With the exception of one subject area to be noted; that of New Brunswick's computing facilities; and a second to be clarified; that of generating exams; all objectives in Appendix A of the contract and in the system specification sheet as submitted by J. A. Gordon Booth are understood and will be provided for in the proposed item banking system.

New Brunswick's Computing Facilities

Since New Brunswick is developing the software for the Item Banking Project, it is reasonable to assume that the computing equipment and software which New Brunswick currently owns and have expertise in will be used to develop the system. The item banking pilot project will be designed and implemented on the Hewlett Packard 3000 Series 40 minicomputer. At present the facilities on the system include:

- 32 computer ports.
- 2 megabytes of memory which is expandable to 3.
- 1 high-speed magnetic tape drive which can support tape density of 1600 and 6250 bpi. The system can support 2 of these.
- 2 - 404 megabyte disk drives.
- The system can support up to 8 disk drives.
- 2 on-line printers which can print 200 characters/second. In letter quality mode they can print at a speed of 67 and 40 characters/second. They are also capable of supporting graphics and barcode characters. These printers will support bilingual characters.
- 1 on-line 180 character/second printer.
- Dial-up access which can support one user at a time.
- Over 40 terminals on-line of which some are stand-alone personal computers.
- 1 - 300 LPM system printer, capable of printing bilingual characters.
- 1 - Data switch which provides the ability to connect more than 32 terminal devices at one time (although only 32 can be logged on at any one time).
- National Computer System Sentry 3000 Optical Mark Reader (connected to computer and terminal).

All software with the exception of that which produces list-type reports and ad hoc reports will be written in Hewlett Packard BASIC/3000. The nature of this language allows programs to be run interactively for testing purposes while providing the option of compiled programs for production use.

Any reports and inquiries which are not produced through a BASIC program will be created through a report writer called QUIZ. QUIZ is not a product of HP but it does run on HP 3000 computers as well as many other systems.

All data entry and viewing screens will be produced using HP's forms design package VIEW/3000. This is a very useful and easy-to-use package since the programming steps of displaying a screen, prompting for data, and doing edit checking are all done via interactive fill in the blank forms. Initally VIEW/3000 was supported only on HP terminals. There is however a new software product called PREVIEW which enables almost every possible type of VDT to support VIEW/3000.

Generating Exams

As requested in the specification sheet, exams will be generated both manually and randomly. However, other than the statement (provision for the presentation of particular trade examination items electronically or in hard copy such that the resulting examination respects the criteria specified on the examination prescription sheet that was prepared by the Examination Officer) found in Appendix A of the contract, no specifics have been provided as to how the random selection of items should be performed. Since it is important that the system produce good quality exams which tests on all important areas of knowledge pertinent to the trade and which separates the qualified candidates from the unqualified, the selection of items should not be left to random chance.

Exams generated in a purely random way may be extreme in the difficulty of the items chosen and the range of the topics covered. It is possible to modify the approach to random selection slightly so that a required number of items from various trade areas are choosen from groups of 'like' items. A prescription stored on the computer would indicate the percentage of items which must fall within each of the difficulty ranges and which must come from the trade areas covered by the exam.

Exam Difficulty

The difficulty value measures the degree to which each item is a challenge to the knowledge of the candidate. The following D.V. ranges result in an exam which is of average to easy difficulty.

	DV Range	# of items	Average DV
1	90 - 94	5	92
2	80 - 89	10	85
3	70 - 79	35	75
4	59 - 69	35	64
5	48 - 58	10	53
6	31 - 47	5	39

Using this concept would ensure that all exams generated by the item bank are of equal difficulty.

Discriminatory Index

Will it be used in conjunction with D.V. separates those who know item from those who do not know item and got it right by accident. Suggests that it is a weak item.

Exam Weighting

The exam weight provides the percentage of questions from the overall exam which must come from each area of the trade. Proper weighting is applied by determining each area's relative importance to the other areas of the trade.

The areas of the trade or trade content is usually organized into a hierarchial relationship with the major areas sub-divided into several topics which combine to make up the major area. These sub-divisions can be further divided into distinct areas of the trade. The terminology used to describe relationship between trade areas may differ from province to province but the concept of organizing the trade is very similar.

In New Brunswick we divide our trades into several major areas of competency which we call BANDS for modular trades (designated with a capital letter) or SECTIONS for conventional trades (designated with a number).

Within each major area of competency are several major skill areas called MODULES for modular trades (designated with a capital letter matching the BAND and a number) or SUB-SECTIONS for conventional trades (labelled with a number matching the SECTION plus a number).

Within each skill area there are many sub-skills called TASKS and are designated with a lower case letter. The notation TASK is used for both modular and conventional trades.

A graphical example of a trade content may be as follows:

BANDS	MODULES	(Task within Modules)		
10% A	A-1 (a) 10% (b) (c)	A-2 (a) 15% (b)	A-3 (a) 25% (b) (c) (d) (e)	A-4 (a) 50% (b)
15% B	B-1 (a) 15% (b)	B-2 (a) 20% (b) (c)	B-3 (a) 20% (b)	B-4 (a) 45%
25% C	C-1 (a) 55% (b) (c)	C-2 (a) 45%		
50% D	D-1 (a) 30% (b)	D-2 (a) 30% (b) (c) (d) (e)	D-3 (a) 40% (b) (c) (d)	

Once a trade has been set up in this format, its subject areas can be weighted by determining the relation of the importance and frequency of each area relative to the remainder of the trade. Provincial advisory committees and surveys of employers in the industry may prove helpful in doing this. (This is piggybacking on a concept used by Ontario over the past years.)

In the previous figure to the left of each BAND label is a percentage value indicating the relative importance of that BAND to each of the remaining BANDS. Under each MODULE label is a percntage value indicating the relative importance of each MODULE to each of the other MODULES within the same BAND.

The sum of values for all BANDS must total 100% as is the case of the values for all MODULES within one BAND.

The importance of a TASK and the frequency with which it is performed in the work force would be gathered on data sheets as shown in the following example:

		IMPORTANCE			FREQUENCY		
		Very Impt	Impt	Not Impt	All Time	Oftn	S/N
		2	1	0	2	1	0
A-1	a	x			x		
	b		x			x	
Sample	c			x	x	x	
A-2	a		x		x		
	b	x				x	
A-1	a	x				x	
	b		x			x	
	c		x		x		
	d			x		x	
	e	x				x	
B-1	a	x				x	
	b	x			x		
B-2	a		x			x	
	b		x			x	
	c		x				

The TASKS are rated on a scale of 0 to 2 for importance where 0 is un-important and escalating to 2 where it is very important; and also a scale of 0 to 2 for frequency where a task rated at 0 is seldom or never performed while a task rated at 2 is performed all the time.

MODULE UNIT	A-1			A-2		A-3					B-1		B-2		
TASK	a	b	c	a	b	a	b	c	d	e	a	b	a	b	c
Survey # 1	4	2	1	3	3	3	2	3	1	3	3	4	2	3	3
Survey # 2	3	0	0	2	3	1	1	2	0	2	1	3	1	2	1
Survey # 3	3	1	1	1	1	2	1	1	1	2	2	2	1	3	2
Survey # 4	4	1	1	3	3	2	0	3	1	3	1	1	2	3	3
Survey # 5	3	1	0	3	2	3	1	3	0	4	0	2	0	4	3
Survey # 6	3	1	0	2	2	2	1	2	1	2	3	2	1	2	2
Survey # 7	2	2	1	2	3	2	0	2	1	3	2	3	2	3	1
Task Total	22	8	4	16	17	15	6	16	5	19	12	17	9	20	15
Module Tot.	34			33		61					29		44		

From the survey results total the sum of the importance and frequency by TASK for all the surveys. Do this for all MODULES (see TASK TOTAL).

Secondly, total the sums of each TASK by MODULE for all MODULES (see MODULE TOTAL).

The following examples show exams for a single MODULE, for several MODULES within the same BAND and for several MODULES covering different BANDS. This formula can also be used for an entire trade, an entire BAND, groups of BANDS, and groups of MODULES spread over several BANDS.

EXAMPLE 1. For a MODULAR exam (A-1) and assuming 50 items on the exam determine the distribution of the items across the MODULE by:

calculate number of items per task.

TASK a: 22/34 * 50 = 32
TASK b: 8/34 * 50 = 12
TASK c: 4/34 * 50 = 6
50

The selection of the 50 items would be broken down to 32 items from TASK a, 12 from TASK b, and 6 from TASK c. All items would be choosen according to the recommended difficulty distribution scale shown on page 22. (This assumes that all items have a difficulty value.)

EXAMPLE 2. For a group of MODULES (as per A-1, A-2 and A-3) and assuming 100 items on the exam determine the distribution of items:

Determine the number of items per MODULE by calculating the ratio of each MODULE to the overall BAND

MODULE A-1 : 10/50 * 100 = 20
MODULE A-2 : 15/50 * 100 = 30
MODULE A-3 : 25/50 * 100 = 50
100

Calculate the number of items per TASK within MODULE

MODULE A-1: TASK a : 22/34 * 20 = 13
TASK b : 8/34 * 20 = 5
TASK c : 4/34 * 20 = 2
20

MODULE A-2: TASK a : 16/33 * 30 = 15
TASK b : 17/33 * 30 = 15
30

MODULE A-3: TASK a : 15/61 * 50 = 12
TASK b : 6/61 * 50 = 5
TASK c : 16/61 * 50 = 13
TASK d : 5/61 * 50 = 4
TASK e : 19/61 * 50 = 16
50

EXAMPLE 3. For an exam which covers more than one BAND, (as per A1, A3 and B2) and assuming 130 items on the exam.

The first calculation is to determine the number of items per BAND, by MODULE using the relative importance percentage given for each BAND and MODULE from the industrial survey or advisory committee.

Determine the weighting of each MODULE by BAND, which gives the exam a total weighting of 4.

BAND A: MODULE A-1: 10% (module) of 10% (band) = 1
MODULE A-2: 15% (module) of 10% (band) = 1.5 (2)

BAND B: MODULE B-2: 20% (module) of 15% (band) = 1.3 (1)

Divide the number of items on the exam by the total exam weight of 4 to get a scaling factor of 33.

(130/4=32.5)

The number of items per MODULE is calculated as the product of the scaling factor and the MODULE weight.

BAND A:	MODULE A-1:	33 * 1 = 33 (items)
	MODULE A-2:	33 * 2 = 66 (items)
BAND B:	MODULE B-2:	33 * 1 = 33 (items)

Determine the number of items per TASK

BAND A:	MODULE A-1:	TASK a: 22/34 * 33 =	21
		TASK b: 8/34 * 33 =	7
		TASK c: 4/34 * 33 =	3
			31
	MODULE A-2:	TASK a: 16/33 * 66 =	31
		TASK b: 17/33 * 66 =	33
			64
BAND B:	MODULE B-2:	TASK a: 9/44 * 33 =	6
		TASK b: 20/44 * 33 =	14
		TASK c: 15/44 * 33 =	11
			31

Due to rounding of digits after the decimal point in the calculations the total number of questions may vary from the requested number of items slightly. When this occurs the program can reduce the number of items in the appropriate section.

Trade Content

The trade content is the number and content of the BANDS, MODULES and TASKS which make up the trade. The bare bones of the trade an example of which was shown in an earlier example and optionally the trade descriptions must be stored on the computer to make use of the described method of exam weighting.

IP CODE OR PROVINCE CODE

TRADE CODE

MAJOR AREA OF COMPETENCY (BAND) AND PERCENT OF THE ENTIRE TRADE

TRADE SKILL (MODULE)

TRADE SUB-SKILL (TASK) AND IMPORTANCE

TRADE DESCRIPTION (to be used for the examination section titles)

Exam Prescription

The prescription for an exam can be prepared and stored on the computer for future and continious use. For in-province use this prescription can be displayed on the screen and changed if desired. The information retained for an exam is:

IP CODE OR PROVINCE CODE

TRADE CODE

LEVEL

PASSMARK

RANGE FOR NUMBER OF QUESTIONS (upper and lower)

RATIO OF DISCRIMINATORY INDEX

RATIO OF DIFFICULTY VALUE

PERCENTAGE OF QUESTIONS FOR EACH TYPE OF TAXOM

PERMITTED NUMBER OF LIKE/SIMILAR ITEMS

Other types of information can be added such as:

OTHER SECTIONS TO BE INCLUDED AND PERCENTAGE OF QUESTIONS FOR EACH

OTHER SKILLS TO BE INCLUDED AND PERCENTAGE OF QUESTIONS FOR EACH.

APPENDIX "B" - FIELD TEST OF EXAMS

Population

For the consistency test, one hundred and twenty-three candidates across Canada wrote the two test examinations. Half of the candidates wrote test examination 925 first followed by 927, while the other half wrote 927 first and then 925.

For comparing methods of administering examinations, twenty candidates from New Brunswick, ten francophones from Edmundston and ten anglophones from Moncton, wrote the two test examinations. Ages of those from New Brunswick ranged from 25 - 41 with 29.5 years as a mean age. Each New Brunswick candidate wrote one examination in hard copy format (either 925 or 927) and the other by interacting with a computer terminal. Only two of the twenty candidates had any previous, and limited, exposure in using computers.

All participating candidates were either completing or recently graduated apprentices. No female candidates were available.

Methodology of the Comparison Test

A time restriction of 1 1/2 hours was placed on candidates who wrote the examination in hard copy format; however, those interacting with the computer did not have any writing time restrictions. Observers, determined that these candidates took an average of 1 hour and 45 minutes to write each examination using the computer. Following the writing of both examinations, New Brunswick candidates were asked to express their preference for one of the two formats written, their apprehensiveness in interacting with the computer, and what suggestions they wished to put forth that would improve the computer format of examining.

Results of the Comparison Test

Of the two formats presented most candidates expressed preference for interaction with the computer terminal. The most significant and frequent reasons put forward for this examination were:

(a) the instant feedback;

(b) the elimination of answer sheets along with the fear of not filling in the proper blanks; and

(c) most enjoyed the computer's continued follow up and updating of items to be reviewed or those left unanswered.

The two candidates who expressed a difference of opinion for preference of format did not choose to provide reasons for their choice.

Reaction to the VDT Administration

Candidates were not intimidated by the computer nor were they apprehensive about using it to write the examination. By contrast they commented that it was "interesting" and "fun." These comments, however, could have been due to the no pass/fail scores attached to the examinations or because of their prior knowledge that they were to be the first candidates in the country to participate in this experiment.

Some difficulties candidates experienced are as follows:

1. Candidates did not understand how to sign on; they considered this part of the program much too complex.

2. The program lacked instructions on how to use specific keys like the enter key, tab key, space bar and shift key.

3. Candidates were unable to relate the eight function keys on the keyboard as displayed on the screen.

4. They did not recognize the word "item", as it appeared throughout the program, as being a "question."

5. Although the program indicated that an individual could change a response to a question and/or flag it for review, candidates did not know how to go about this procedure.

6. Once a graphic was displayed on the screen the program did not provide a message on how to get back to the question.

7. Candidates thought they could call for a metric diagram by pressing function key 2 when they already had the imperial diagram displayed on the screen.

8. Some candidates would press the numeral button (1-8) when the program actually required them to press function key (1-8).

9. Some did not understand what the program messages of "Caps", "normal", and "review" meant, and they had to ask.

10. The speed in which the diagrams are being communicated is too slow and needs to be greatly improved. Either that or show the diagram and the item on the same screen.

Some of the comments and recommendations put forth by the candidates for improving the computer version were:

(a) the provision of a pretest for first time writers;

(b) providing a smaller keyboard having only the required keys on it; and

(c) make the program more user friendly by adding more messages.

Results of the Consistency Test

The following comparison chart offers evidence that the computer does generate examinations consistently against the same standard.

Comparison of the two Computer Generated Examinations		
Examination Version	925	927
Number of Examinees	119	123
Mean	54%	57%
Median	51.5%	55.5%
Mode	56%	56%
Standard Deviation	9.29	11.76
Range of Scores	31-72	28-83
Number Passed	1	14
Number of Questions on examination	There are 66 questions on each examination but 30 questions on each version were found to be invalid; therefore, we base our findings on the remaining items.	

ANNEXE B - MISE À L'ESSAI DES EXAMENS EN SITUATION RÉELLE

Participants

Pour la vérification de la cohérence, cent vingt-trois candidats disséminés au Canada ont passé les deux examens-pilotes. La moitié des candidats on d'abord subi l'épreuve 925, puis l'examen 927, et l'autre moitié les a passés dans l'ordre inverse.

Afin de comparer les méthodes employées pour faire passer les épreuves, vingt candidats du Nouveau-Brunswick, dont dix francophones d'Edmundston et dix anglophones de Moncton, ont subi les deux examens. L'âge des candidats du Nouveau-Brunswick variait de 25 à 41 ans, la moyenne se situant à 29,5 ans. Chaque candidat néo-brunswickois a répondu à un examen (le 925 ou le 927) sur papier, et à l'autre au moyen d'un terminal d'ordinateur. Seuls deux de ces vingt candidats avaient déjà utilisé un ordinateur.

Tous les participants terminaient leur formation ou étaient des apprentis récemment diplômés. Aucune candidate n'a pu faire partie de l'évaluation.

Méthodologie de l'évaluation comparative

Une limite d'une heure et demie a été imposée aux candidats qui répondaient sur papier; toutefois, ceux qui ont subi l'examen informatisé n'étaient soumis à aucune restriction de ce genre. Les observateurs ont déterminé que les candidats ont pris en moyenne 1 h 45 pour terminer chaque examen à l'aide de l'ordinateur. Après les deux épreuves, on a demandé aux candidats du Nouveau-Brunswick d'exprimer leur préférence quant aux deux formes d'examens, leur appréhensions face à l'ordinateur et les suggestions qu'ils désiraient formuler en vue d'améliorer l'examen automatisé.

Résultats et discussions

Des deux formes d'épreuves soumises au candidats, ceux-ci ont préféré l'interaction avec le terminal d'ordinateur. Les raisons les plus souvent invoquées pour justifier cette préférence étaient les suivantes:

(a) réaction instantanée;

(b) élimination des feuilles de réponse et de la crainte de ne pas remplir les bonnes cases; et

(c) la plupart ont apprécié la révision permanente de l'ordinateur et la mise à jour des items à revoir et des questions sans réponses.

Les deux candidats qui ne partageaient pas l'avis de la majorité ont choisi de taire leurs raisons.

Les candidats n'étaient pas intimidés par l'ordinateur et ils n'avaient aucune appréhension quant à son utilisation en vue de subir un examen. Au contraire, ils ont fait remarquer que son emploi était "amusant" et "intéressant". Toutefois, on peut peut-être attribuer ces remarques au fait qu'il n'y avait aucune note de passage à l'examen ou que les candidats savaient à l'avance qu'ils étaient les premiers au Canada à prendre part à cette expérience.

(Difficultés rencontrés par les candidats lors de l'examen automatisé)

1. Les candidats ne comprenaient pas comment s'inscrire au système; ils considéraient que cette partie du programme était beaucoup trop compliquée.

2. Le programme ne donnait pas assez de directives sur l'emploi de touches précises telles les touches d'entrée, de tabulation et de majuscules, ainsi que de la barre d'expacement.

3. Les candidats ne pouvaient faire la relation entre les huit touches de fonction et leur représentation à l'écran.

4. Ils ne faisaient pas le lien entre le terme "item" qui paraît dans tout le programme et sa signification, soit "question".

5. Même si le programme indiquait que l'utilisateur pouvait modifier sa réponse et la repérer afin de la revoir, les candidats ne savaient pas comment s'y prendre pour y arriver.

6. Quand un graphique était affiché à l'écran, le programme ne donait aucun message sur la façon de revenir à la question.

7. Les candidats croyaient qu'ils pouvaient faire apparaître un schéma métrique en appuyant sur la touche de fonction 2 lorsqu'un schéma en mesures impériales était affiché à l'écran.

8. Certains candidats appuyaient sur les touches numériques (1-8) quand le programme leur demandait d'utiliser les touches de fonction (1-8).

9. Certains ne comprenaient pas le sens des messages "Caps", "normal" et "révision" et on dû le demander.

10. La vitesse d'affichage des schémas est trop lente et doit être considérablement accélérée. On peut opter pour cette solution ou encore faire en sorte que le schéma et l'item soient affichés en même temps à l'écran.

Voici certaines des remarques et recommandations formulées par les candidats au sujet de l'amélioration de la version automatisée:

(a) une épreuve préliminaire à l'intention des candidats qui passent pour la première fois un examen de ce genre;

(b) un plus petit clavier ne présentant que les touches nécessaires; et

(c) rendre le programme plus facile d'utilisation en ajoutant des messages.

Résultats de l'examen de cohérence

Le tableau comparatif suivant prouve que l'ordinateur produit des examens avec cohérence par rapport à une norme uniforme.

Comparaison des deux examens produits par ordinateur		
Version	925	927
Nombre de candidats	119	123
Moyenne	54%	57%
Médiane	51,5%	55,5%
Mode	56%	56%
Déviation normale	9,29	22,76
Écart des notes	31-72	28-83
Nombre de réussites	1	14
Nombre de questions dans chaque examen	Chaque examen contient 66 questions, mais 30 questions de chacune des versions ont été jugées invalides; nos conclusions sont donc basées sur les items restants.	

APPENDIX "C"

INTERPROVINCIAL STANDARDS PROGRAM COORDINATING COMMITTEE

POLICY STATEMENT

(DRAFT: FOR DISCUSSION PURPOSES ONLY)

SUBJECT: Computerized Item Banks - Access

BACKGROUND:

When the pilot project for the Electrical Trades Computerized Item Bank is complete, it will contain approximately 4,500 items gathered from all provinces and territories in Canada. Item banks for other trades, as they are completed, will contain a similar number of items. It is anticipated that groups such as other provincial or territorial Departments, Community Colleges, etc., will wish to have access to the banks. It is important that proper security be maintained and that great care be exercised regarding the release of these items.

POLICY:

No direct access to the item banks is to be permitted other than to ISPCC or ISEC members for use in Apprenticeship programs only.

The release of Items from the banks may be permitted to organizations other than ISPCC or ISEC, upon request, provided all identifiers (province of origin, trade level, D.V., D.I., etc.) except correct response have been removed.

All requests for such release should be made in writing to the Director of Apprenticeship (or equivalent) for the province/territory of origin of the request. The organization or agency making the request should identify the

use and subject area of that part of the bank they are requesting. Upon approval of the request, the Director will advise the ISEC representative for the province/territory who will arrange for the release of the material from the Item Bank concerned.

In deciding whether or not to approve a request for release of items from a bank, consideration should be given to the purpose for which they are to be used and the function of the organization making the request. As a general rule, only organizations concerned with training and/or certification would be considered. Items released would contain stem and responses only, with correct response indicated and all other item identifiers removed.

October 6, 1986

ANNEXE C

COMITÉ DE COORDINATION DES PROGRAMMES DE NORMES INTERPROVINCIALES

DÉCLARATION DE PRINCIPES

(ÉBAUCHE: POUR FIN DE DISCUSSION SEULEMENT)

OBJET: **Banque d'items automatisées - Accès**

CONTEXTE:

Lorsque le projet-pilote d'une Banque d'items automatisée pour les métiers de l'électricité sera terminé, celle-ci contiendra environ 4 500 items répertoriés dans toutes les provinces et les deux territoires du Canada. Les banques d'items relatives aux autres métiers renfermeront un nombre semblable d'items une fois qu'elles seront au point. On prévoit que des groupes comme d'autres ministères provinciaux et territoriaux, les Collèges communautaires, etc. désireront avoir accès aux banques. Il est important d'assurer une sécurité convenable et de diffuser ces items avec grande circonspection.

LIGNE DE CONDUITE:

On ne permettra aucun accès direct aux banques d'items, sauf aux membres du CCPNI et du CENI à condition que toutes les caractéristiques d'identification (province d'origine, niveau d'emploi, VD, ID, etc.), sauf les bonnes réponses, soient éliminées. Toutes demande concernant une telle diffusion doit être faite par écrit au directeur de l'apprentissage (ou à la personne occupant un poste équivalent) de la province ou du territoire d'origine de cette demande. L'organisme demandeur doit signaler l'usage qu'il compte faire des items ainsi que le domaine de la banque qui fait l'objet de sa demande. S'il approuve la requête, le directeur communiquera avec le représentant du CENI pour

la province ou le territoire, lequel prendra les dispositions nécessaires à la diffusion du matériel de la banque d'items visée. Au moment de décider d'accorder ou non une approbation quant à la diffusion d'items d'une banque, on doit prendre en considération leur utilisation ainsi que le rôle de l'organisme demandeur. En règle générale, seuls les organismes s'occupant de formation et d'homologation devraient être retenus. Les items diffusés ne contiendront que le corps et les réponses, la bonne solution étant indiquée; toutes les autres caractéristiques d'identification seront éliminées.

Le 6 octobre 1986

APPENDIX "D"

GRAPHICS FOR A COMPUTERIZED EXAMINATION MANAGEMENT SYSTEM

A Report Prepared for

The Department of Advanced Education and Training

Fredericton, New Brunswick

by the

Manufacturing Technology Centre
University of New Brunswick

September 30, 1987

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1. EXECUTIVE REVIEW

This study was carried out with the mandate to investigate the current methods the Department of Advanced Education and Training were using to produce graphics; analyze any problems and investigate alternate means and make recommendations for such.

The following are the major points of this report.

The inclusion of graphics is necessary to logically complete the system.

It is possible to provide diagrams necessary to candidates in the form of a book of all possible figures. This is a much less desirable scenario than having the computer present the graphics to the candidate. Under computer control, we can ensure that the candidate is utilizing the correct diagram. This is not possible if they are to look up the diagram themselves.

The Department of Advanced Education and Training has made a very creditable effort to include graphics in the pilot project, especially considering that this was an addition to the original scope.

Problems which have been discovered are in general ones that can be solved with more software development, different hardware configurations and the knowledge gained by the experience.

The graphics which have been produced to date are too device -dependent, time-consuming to display and costly to produce.

Alternate methods can be utilized to allow support for more than one graphic device, allow printing of graphics and provide for a fast display of the picture, and eliminate some of the complexities of the current system which is used to create and convert the graphics.

The graphics interfere with the display of special characters within the alphanumeric text.

The creation of special graphic characters for some mathematical expressions greatly enhances the system, allowing the concise phrasing of examination questions. Thus, this feature should be retained. It will not work well on the current configuration (HP150) because it is not possible to have both special characters and the drawing in the graphics memory at one time. Thus, every time the candidate switches between alphanumeric (the question) and graphics (the diagram) the graphic memory has to be regenerated from the host, a slow procedure. A solution is to use two graphic screens, one for the question and one for the diagram; or one screen and one graphics printer, the screen for the question and the printer for the diagram.

Transmission of graphics over telecommunication lines will be relatively slow and costly.

Graphics involves large amounts of data. Telecommunications at 9600 BAUD was shown to be too slow a speed to transmit graphics. Telecommunications at 19.2 Kbaud, now available for DATAPAC, should be tested for improvement. It is our recommendation, however, that the graphics be stored locally in a distributed system of Host computer and microcomputers. This cuts down the cost of writing an examination significantly. We do not propose that control of the writing of the examination be passed to a microcomputer. There are many reasons for this, not the least the security and error-checking which has been incorporated into the main program.

A system has been tested to allow for local storage and retrieval of the graphics, while maintaining the control over the examination process at the host computer.

Graphics may effectively be produced using a two screen system or a one screen, one printer system.

A configuration of one monochrome graphics monitor for presentation of the question text and a high resolution monochrome monitor for graphics would be ideal. Another possible combination is one monochrome monitor for the question and a printer for graphics.

The configuration chosen must be "acceptable" to DOS. That is, the Disk Operating System must be able to differentiate between the two screens. In practical terms, at this point in DOS's development, one screen must be a color screen. When hardware is chosen, this must be kept in mind.

It would be desirable to offer users a choice of configuration.

There are available a wide variety of monitors and graphics cards. We recommend supporting a small range of devices to allow users some choice. To accomplish this, the first conversion of graphics must be in a 'generic' form, suitable for subsequent translation for different types of graphics screens.

It is recommended that a well established industry standard for the graphics be chosen.

Adherence to one graphics standard which many graphics cards and monitors support is adviced. We recommend the choice of a standard such as GEM (Digital Research Corporation) or Microsoft Windows (Microsoft Corporation) Then there will be a range of choice of graphics cards, and off the shelf software development tools will be available to produce and store the graphics files. This has the added advantage of increasing compatibility of the system with other software packages, facilitating future expansion and development of the system, and increasing the end user's choice of other applications to run on their microcomputer systems. For example, the GENOA card listed in appendix I3 can be used to run Autocad (A CAD system by Autodesk), Microsoft Windows and any GEM based product.

2. PURPOSE AND GUIDELINES FOR THE STUDY

The Department of Advanced Education and Training has developed a pilot project to provide a system of computerized examinations for the interprovincial trades. They have designed a computerized item bank and an examination generation, writing and marking system which links to a computerized interprovincial candidate registration system. During the development of the pilot project, the question of providing diagrams associated with examination questions using computer graphics arose. The Department of Advanced Education and Training added this task to the scope of their project and included the computer graphics in the pilot system.

Some 1200-odd drawings were prepared at the Manufacturing Technology Centre (MTC) at the community college campus in Moncton on their UG (UNIGRAPHICS I) CAD/CAM system. These drawings were then translated into graphics data suitable for display on the HP2623A screens which had been selected for use in the examination system. The graphics data was produced in the form of ASCII data files of vector graphics commands which could be accepted by the graphics processor of the HP2623A. At the time that

this program was written, it was assumed that the 7 by 5 inch screen would be used to display the data, that relocatable graphics format was required, and the program written accordingly. This program was written at the MTC-UNB for use on the VAX 11/780 computer running the UG I system at the Moncton campus.

Results of pilot testing showed that the implementation of graphics is feasible, however some problems relating to the nature and quality of the graphics produced, the cost of developing the data and the speed of displaying the graphics data were encountered. It was decided that the use of on-line computer graphics was desirable, and therefore this study was commissioned from MTC-UNB, with the following specific directives:

1. **Analyze the problems, if any, that we encountered with the students hired to create the graphics at our Moncton Campus. In other words was it students we should have employed or an experienced member from the work force.**

2. **Double check the conversion program to determine if it is accurate.**

3. **Determine the "true" level difficulty we are experiencing in having graphics displayed on the large screen HP150.**

4. With the objective, "To be able to create and edit graphics on a daily basis," in mind, then determine if the UG system is necessary for creating the graphics for this project or is there a reasonable alternative(s)?

5. Can the text of the questions be merged with the graphics on a hard copy print out, using hardware similar to the HP Laser Jet Series II printer? Currently we do not have the capability to do this, and I am sure this will be a future requirement.

6. Determine just how compatible our system is with other kinds of hardware.

7. Provide the information on the costing of at least three potential methods for incorporating graphics into the system.

3. STUDY METHODOLOGY

The MTC carried out the following activities in the execution of this study:

1. Analyzed the computer code which was developed at MTC-UNB to translate the UG drawings into HP2623A graphics commands.

2. Interviewed the MTC-CCM personnel who supervised the production of drawings at their CAD/CAM centre.

3. The Department of Advanced Education and Training and the Department of Labour personnel involved with the incorporation of the graphics into the exam system were consulted as to their methods.

4. As a result of (1) the computer code to translate UG drawings to HP graphics data files was modified and the results tested.

5. MTC-UNB investigated the capabilities of the REFLECTIONS emulator and the use of IBM or IBM compatible PCs in place of the HP150 systems.

6. Alternate methods of producing drawings were investigated and noted - e. g. using PC-based CAD systems, manual drafting, use of photographs.

7. Methods of converting drawings to graphics data files were investigated. Methods included conversion programs (such as the one currently in use), rasterizations programs, and scanning systems.

8. Methods for storing and presenting the graphics data were investigated, and a two screen system was configured and tested using the REFLECTION HP terminal emulator and an IBM PC/AT. It was shown that local storage and retrieval of graphics would work.

9. The costs and availability of different graphics cards and monitors was researched.

10. Methods of printing examinations including the question text and related graphics data were investigated.

4. RESPONSES TO SPECIFIC QUESTIONS

1. Analyze the problems, if any, that we encountered with the students hired to create the graphics at our Moncton Campus. In other words was it students we should have employed or an experienced member from the work force.

There were no real technical problems, but some improvements are possible. Drawings were initially produced inefficiently (i.e. in less than optimum time) before a good smooth production process was developed, involving the use of layers to include all combinations of languages and measurement systems. These are normal problems when initially untrained personnel are used. If an experienced member of the workforce were used, the learning curve (in terms of UG techniques) would of course be much shorter. There would, however, still be a learning curve involved in sorting out the best methods to produce the drawings. The work produced by the Moncton Campus students seems to be of high quality in its final state, and the development of the production methodologies appears to have been a normal one.

Some suggested improvements in the construction methods for the drawings are:

1. Use a tighter curve tolerance; the use of .001 versus .002 (present value) resulted in smoother arcs with only a minor increase in generation time (about 8%)

2. Drawings should be created with their end use in mind; this would mean attempting to keep details (text in particular) as large as possible while maintaining an acceptable appearance.

3. The use of the simplest block format for text is necessary for readability.

2. Double check the conversion program to determine if it is accurate.

1. The conversion program was the source of several problems. The major problem arose from the fact that it was designed to convert for a slightly larger screen. (The reason for this change is unclear - the first version of the program was written for a 7x5 inch screen. Then a second version was produced with slightly larger scaling factors.) As a result the figures produced extended past the screen boundaries. These were again scaled by the Department of Labour personnel, resulting in distortions in the figures.

2. There were some truncation errors when rounding the vector data to integer coordinates.

This program was modified to correct these errors, resulting in an improved result. (See Appendix I1).

Additional suggestions:

1. Conversion subroutine PLOT should be modified to change the uppercase letters in the escape codes to lower case.

2. The program creates the HP2623A commands in relocatable format. Drawing production time would be shortened if absolute format were used.

3. When a tape is made, the files could be named in the format required by the loading software.

4. If this method is to be continued, a "generic" plot file should be created which could then be translated for many screens via a simple extension of the conversion program. In other words, the first conversion program should not convert to screen coordinates and commands specific to the HP2623A. It should just produce a file of graphics vector coordinates in a documented form which could then be processed for a particular screen.

3. Determine the "true" level difficulty we are experiencing in having graphics displayed on the large screen HP150.

Some of the indicated difficulties with graphics on the HP terminals could be overcome by following the suggestions listed in 1. and 2. above. The "bottom line" is still the limited resolution of the monitor. The modifications made to the conversion routines produced as accurate a conversion as we believe possible. The fact remains that this monitor is not suitable for displaying complex drawings such as the floor plans which contain a great deal of detail. Improvements in other drawings could be attained by eliminating small details whenever possible, and the consideration of the end use of the diagrams as they are produced on the CAD system.

The production of text on this screen could in some cases be enhanced by utilizing the graphics text commands rather than the translated characters from UG.

4. **With the objective, "To be able to create and edit graphics on a daily basis," in mind, then determine if the UG system is necessary for creating the graphics for this project or is there a reasonable alternative(s)?**

The answer to this question is dependent on the type of graphics file which will be produced. There are two alternatives:

1) "Vector" graphics data, as has been produced so far
2) "Raster" graphics data

If (1) is the choice, then the drawings must be produced on a CAD system which allows access to the data to produce, via a conversion program, the vector commands necessary. UG is such a system, however some other CAD systems allow this as well. For example, the CADKEY (Micro Control Systems Inc.) system will produce a "plot file" of vectors which could be converted to vector commands for the screen used. More advanced systems such as UGII (UNIGRAPHICS II, McDonnell Douglas Information Systems Company) would allow further optimization of data by extracting text from the drawing via a program such as GRIP

which can access the part data file and determine the text characters, their location and their character size. The use of the UG system for the drawing production is a reasonable choice, particularly if equipment is to be available free of charge in the future. It is not the only choice of CAD system. The critical factors to be considered in selection of a CAD system for this application are:

1. The ability to produce "plot" files on permanent storage.

2. The ability to produce these at high resolution.

3. The ability to interface to the CAD database to obtain information about the geometry and text contained in it is desirable.

If (2 - SCANNING) is the choice, then the drawings could be produced in any way, including manual drafting and sketching. This would also open up possibilities for the use of photographs.

5. Can the text of the questions be merged with the graphics on a hard copy print out, using hardware similar to the HP Laser Jet Series II printer? Currently we do not have the capability to do this, and I am sure this will be a future requirement.

This can be done. It would be necessary to have the graphics data available in a "raster" format for the laser printer. This can be done by either storing the graphics in a raster format, converting it by means of a conversion program, or by first storing it in the HP150 graphics memory and then sending it to the printer. (In this case, the HP150 converts to the laser format for you.)

A simple page formatting program would have to be written to position the text and graphics appropriately on the printer. For this study, only the Hewlett Packard Laserjet II was investigated. It was determined that this laser printer is capable of producing the required result. In general, the printer to be used must support the following functions:

1. Allow "begin raster data" and "end raster data" commands.
2. Allow "cursor positioning" via commands.

As mentioned in the executive summary, adherence to a graphics standard would allow the production of raster graphics directly compatible with a page formatting system such as Microsoft Windows. If this were the case, an examination could be re-formatted if necessary by utilizing a package such as Windows.

6. Determine just how compatible our system is with other kinds of hardware.

To answer this question,

1. "Our system" refers to the examination generating and testing system written by the Department of Advanced Education and Training personnel and running on HP block mode terminals.

2. "Other kinds of hardware" will refer to the terminals or microcomputers used by the candidate to answer the examination questions.

Firstly, the nature of the code requires that either an HP Block mode terminal or a terminal emulating such be used. One such emulating package was tested, REFLECTION 3, using an IBM PC/AT. This package worked very well, with the exception of displaying the special symbols' which should have appeared within the question text. (The reason for this was not determined.) Graphics are available on the IBM COLOR, ENHANCED, and HERCULES MONOCHROME cards. Since this package seemed to work very well in most cases, no other emulation packages were tested.

This means that with this emulation package, any IBM PC or compatible may be used to access the system. The graphics produced on the IBM PC/AT was superior in the sense that the lines were sharper. The resolution of the supported screens, however, is less than that of the HP2623A and the drawings shown on the screen were elongated in the vertical direction. The elongation problem could be corrected in the conversion program.

If a variety of hardware is to be accommodated, a more general scheme for producing graphics should be devised, rather than converting to graphics for the 512 by 390 resolution screen. The production of a generic plot vector file, or a generic raster data file, which is then translated for the use of different screens, would be advisable. Again, adherence to one graphic standard is advisable.

7. Provide the information on the costing of at least three potential methods for incorporating graphics into the system.

NOTE: All prices in this section are list prices, and may be approximate in some cases. The availability of educational discounts and volume discounts should be considered here.

Costs for incorporating graphics into the system fall into four categories:

7.1 Production of the drawings.

Estimates based on the drawings prepared using the UNIGRAPHICS I system at the community college in Moncton:

Average time/diagram	2-3 hours
Average salary	$12.00/hour

	$24 - $36 per diagram

A plotter would be necessary to produce suitable hard copy.

Plotters Size	Model	Approximate Price
C-D	HI DMP41	5,462
C-D	HI DMP52	7,783
E	HI DMP56A	9,938
C-D	HP Draftpro	9,210
C	Roland DXY2000	7,495

If a CAD (Computer Aided Drafting) system is to be used to create the diagrams, it will be necessary to purchase the software and hardware to run the system.

CAD System

High End system **		$55,000
Software	$26,000 approx	
Hardware	$29,000 approx	
Low End system ***		
Software	$4,695	
Hardware	$9,383.00 (approx)	

** UNIGRAPHICS II DESIGN MODULE ONLY on Vaxstation 2000

*** CADKEY System on IBM PC/AT with IBM enhanced Colour display and adapter.

7.2 Conversion of drawings for the graphic screen(s) to be used.

Software toolkit	800-1000
Custom programs	1 month @ $2,500 (based on $30,000/year)
Scanner	$8,000-$10,000

7.3. The cost of the hardware to be used (by the end user)

Since many configurations are possible, we are simply listing component prices for various microcomputers, storage devices and graphics cards and monitors.

Microcomputers (Processor, keyboard, 1-2 floppy disk drives)

Model	Cost
IBM AT Model 399 (incl 30mb disk)	7145
HP Vectra	4795
IBM System 2 Model 30	2595
IBM System 2 Model 50 (incl 20mb disk)	5495
IBM System 2 Model 60 (incl 44 mb disk)	8245
IBM System 2 Model 60 (incl 70 mb disk)	9795

Graphics Cards and Monitors

Graphics Card	Resolution	Cost
IBM Enhanced Graphics	640 x 350	849
IBM VGA	1024x768	2005
Hercules	720x350	459
Metheus	1024x768	3600
Genoa[1]	1000x800	800

Monitors

Monitor	Size	Resolution	Cost
IBM Mono	12"	640x480	359
IBM Enhanced	12"	640x350	1389
For PS/2 systems			
IBM 8512	14"	640x480	915
IBM 8513	12"	640x480	1059
IBM 8514[2]	16"	1024X768	2399
Microvitec[1]	19"	1000x800	3495
Philips	19"	1024x768	4200
Nth Monitors/adapters[3]			
	13"	640 x 480	6000
	19"	1024x768	10,000 - 14,000 (dep. on monitor)

1 Information supplied by Kemeny Automation, 2453 Guenette, Ville St. Laurent, H4R 2E9.

2 Requires Model 8514 Adapter.

3 These include a local ZOOM feature which would be very useful for viewing complicated diagrams. Compatible with Autocad and Versacad. ZOOM/SLIDE capability available through CAD software.

Storage Devices

Device	Storage	Cost
Optical Disk Drive	200 MB	
A01		4585
B01		4195
Optical Cartridge		115
Hard Disk(VECTRA)	20 MB	2199
IBM Hard Disk	44 MB	2170
IBM Hard Disk	70 MB	3725

Scanners

HP Scanjet	2694
Scanjet Adapter	895
Scanjet total	3,589

IBM 3118

Laser Printer

HP Laserjet II	4495

7.4 The cost of displaying the graphics on the screen.

This would be communication costs if transmitting from the host computer, or the cost of local storage devices of graphics is to be stored at the terminal.

Telecommunications

High Speed Communications lines (19,200 Kbaud) are now available. The monthly rental rate is not known at present.

DATAPAC Rates
Line Rental: (9600 BAUD) 456/month in all provinces except BC. BC (Burnaby) rate $661/month

The cost of transmitting an average diagram, (approximately 26,000 bytes) will vary with the timer setting used on the PAD (X-25 Packet Assembler Disassembler). The pilot test was done with the timer setting at 1/10th of one second. We estimate that with this setting, on a 9600 baud line, 96 characters would be sent per packet. Ignoring the line rental ($456/month) the cost to send 25,000 bytes of data from Fredericton would be:

To	Rate	Total
Winnipeg	2.14	.56
Regina	2.27	.59
Edmonton	2.42	.63
Ottawa	1.52	.40
St. John's	1.67	.44
Halifax	1.15	.30
Charlottetown	2.26	.59
Montreal	1.44	.38

Storage Devices

See section 7.3

APPENDIX T1

METHODS OF PRODUCING GRAPHICS DATA

METHODS OF PRODUCING GRAPHICS DATA

There are essentially two components to this problem.

1. The production of the drawing
2. The conversion of the drawing to data suitable for display on the target graphics terminal.

1. Drawing Production

Many options are available. The constraints assumed here include:

1A. Flexibility and ease of use
1B. Cost
1C. Ease of translation
1D. Ability to print the graphics in combination with the text.

2. Conversion

Constraints assumed here include

2A. Ease of use
2B. Flexibility to produce data for different graphics screens.
2C. Cost (program development and runtime costs)
2D. Flexibility to add photographs, sketches, etc.
2E. Storage and transmission time constraints.

These questions must be answered based on the type of hardware to be used to display, store and print the graphics.

There are two possible formats for the graphics data for computer screens, vector graphics commands such as those produced in the pilot, and binary raster data.

1) Vector graphics commands

This data must be produced in a format which is accepted by the graphics processor resident in the graphics terminal. For example, the HP2623A accepts commands such as

ESC * p a X,Y	MOVE TO LOCATION X,Y
ESC * p b X,Y	DRAW A LINE TO LOCATION X,Y
ESC * I text string	OUTPUT TEXT STRING AT CURRENT LOCATION

The data is preceded by commands to turn on graphics memory. The drawing thus created by MOVING and DRAWING vectors appears on the graphics screen.

If the drawing has been created on a CAD system such as UG, the command file of graphics commands can be produced by a plotting program which converts the screen coordinates of the UG system to those of the HP2623A terminal with the appropriate MOVE or DRAW commands.

When these graphics commands are sent to the HP2623A terminal, they are converted by the graphics processor to a memory map of 0's and 1's which represent pixels either off (0) or on (1).

2. Raster Graphics Data

On some terminals, it is possible to send the memory map of 0's and 1's directly to the graphics memory of the computer. For example, on the IBM color graphics system, the graphics memory begins at location B800. If the appropriate series of 0's and 1's is written directly to the graphics memory, the figure will appear on the graphics screen.

This can be done by a conversion program which converts all vector data to the memory map of 0's and 1's required by the graphics screen to be used, or the picture can be collected by utilizing a scanning device such as the HP Scanjet desktop scanner, or the IBM 3118 or 3117 scanner.

Scanning typically produces large amounts of data. Much more data than required may be produced by a scanner. For monochrome display devices with only one intensity, one bit per pixel is required. The following table lists the file sizes for some typical displays.

Resolution	File size
640 X 200	16 Kbytes
640 X 350	28 Kbytes
1024 X 1024	131.072 Kbytes

Data compression capability is highly desirable for use with scanners.

Scanned data could be read directly into the graphics memory. The display is accomplished very quickly, limited only by the speed of the device being read from. This was tested using an IBM AT and a hard disk device. The display of 16 kbytes of data is accomplished in 2-3 seconds.

Collecting data by scanning methods would give the flexibility of using photographs or sketches. It is an extremely easy way to collect data, attractive to the average user to operate. It would allow the production of the original drawings by any method, including hand drafting, although use of a CAD system is desirable in order to facilitate updates.

APPENDIX T2

STORAGE AND DISPLAY OF GRAPHIC DATA

STORAGE AND DISPLAY OF GRAPHIC DATA

The amount of graphic data required to display one picture averaged[1] 26,465 in the ASCII vector data files used in the pilot[2]. Depending on the resolution of the monitor, 16,000 to 131,072 bytes are required if binary raster data is used. This causes an unacceptable delay if data is to be transferred from the host computer to the terminal at which the candidate is writing. Faster telecommunications technologies may alleviate this problem in the future. The transmission of large amounts of data also increases costs in operating the system.

For these reasons, we investigated the storage of the graphics data locally in a hard disk system. In order to have the correct diagram retrieved at the correct time, some software development would be necessary. It is necessary to temporarily exit from the HOST computer to the DOS operating system, run a program which retrieves the appropriate graphic, display it on the screen, then return to the HOST program. This was tried using an IBM PC/AT running under the REFLECTION emulation program. In order to keep the graphic on the screen after returning to the HOST, a two screen configuration must be used. This seems to be a

1 Based on a total of 10.6 million bytes for approximately 400 diagrams, including English and French text, and metric and British measurements.

2 There is a potential to reduce this amount by (1) storing the text as character strings rather than vectors, and reducing the number of characters in the escape sequences.

We believe this (local storage) to be a reasonable solution, allowing a separate screen for the graphics, fast retrieval of data, and considerable flexibility in the choice of graphics screen used. A limitation to this method is the amount of local storage available. Also, the two screens must appear different to DOS. This means that one must be recognized by DOS as monochrome, and the other as colour.

Using the REFLECTION program, retrieval of graphics from local storage was accomplished by issuing the following series of commands:

ALT Y	go to REFLECTION command mode (OR ESC&oC)
SHELL	go to DOS
pgname	the name of the program to retrieve the graphic
EXIT	to return to REFLECTION
ESC	to exit REFLECTION command mode.

As long as the main program can generate these commands, this method should work. It would be necessary to have a very well structured system of graphic filenames which link to the questions, however this is already the case in the current system.

Other complexities introduced by the proposed method to local storage of graphics data are increased complexity of updating the system and the increased cost of the additional graphics screen.

Local storage devices suitable for this application include hard disks and optical disks. Floppy disks are possible, but slow for transmitting data and extremely limited in storage.

Optical disks are excellent since currently available systems would allow storage of 200 megabytes of data on one cartridge. Their disadvantage is that they are Write Once, Read Mostly (WORM) devices. This means that if one drawing is to be updated on the system, a new version must be appended to the disk, or an entirely new disk created. After a number of additions, the disk would become full and purchase of a new one necessary.

Newer systems such as the IBM system 2 models 50 and 80 allow for hard disks of much larger capacity.

Number of Drawings per Storage Devices (Raster Data)

Resolution of Screen	30 MB Hard disk	200 MB optical disk
1024 x 1024	228	1,525
640 x 360	1,041	6,944
640 x 200	1,875	12,500
720 x 348	957	6,385

TERMINAL EMULATION

The examination system has been developed for terminals using HP block mode format for displaying questions and eliciting responses from the candidates. The system is well thought out, easy to use and trouble free in operation.

In order to utilize an IBM PC or compatible, it is necessary to emulate the screen functions of an HP terminal. One package that works is the REFLECTION software package, a product of Walker Richer & Quinn, Inc. This package is also a communication software and runs under DOS versions 2.0 or later. It supports the IBM PC, XT, AT, and Compaq personal computers or 100% compatible machines. It emulates the HP2392A terminals ,and the IBM color graphics, enhanced graphics, or a Hercules monochrome graphics card. It also supports the SHELL command which would allow execution of a program to retrieve a drawing from local storage.

APPENDIX T3

PRINTING OF EXAMINATIONS WITH GRAPHICS

PRINTING GRAPHICS

The possibilities for printing graphics locally were tested using the HP LASERJET II.

1. USING THE HP150

The graphics memory can be "dumped" directly to the printer by escape sequence programs or by pressing the correct key on the keyboard.

2. USING AN IBM PC

Graphics can be sent to the printer as in (1) if HP2623A graphics emulation is used.

Graphics can be sent to the printer from local storage by means of a DOS program.

3. DIRECTLY FROM HOST

Graphics data can be sent to the printer directly from the host computer if it is available there in rasterized form. This means that the diagrams are either collected and stored in this form, or that program to rasterize the vector data is available. The data must be headed by escape sequences to indicate the printer as the destination device, then to indicate to the printer that the data following is raster data. It must be terminated by resetting the output device to the screen.

3.1 Printing Entire Examination

One question which arose during the course of the study is the feasibility of printing an examination remotely, with graphics included with the question text. Presumably this would allow users to use the system to generate an exam, have it printed, then administered in the traditional method.

This is possible, with some software development. It would be necessary to write a program which would format the questions to a page rather than the computer screen. Given that questions vary widely in the length of the text, and that some have figures associated with them, the program would have to track the number of lines sent; determine whether or not a figure accompanies the question, and handle any special characters which appear in some of the questions. These characters could be generated as downloaded characters to the laser printer and identified as such by the proper escape sequences.

The formatting of the printed exam could be done entirely at the host, then transmitted to the printer, to local storage or both.

There is also the potential to format exam questions with graphics for use with a commercial product such as PAGEMAKER or INTERLEAF which would allow reformatting of the examination at the end user's discretion. It was beyond the scope of this study to determine the difficulty level of doing this. However, if the graphics is created in a format compatible with the page formatting software (e.g. Microsoft and Windows), this might not be too difficult.

REFERENCES and CREDITS

The following publications were used to obtain information for this report.

1. IBM BASIC Personal Computer Hardware Reference Library, Microsoft Corporation

2. HP150 Programmer's Reference Manual

3. REFLECTION Series "USER MANUAL, Version1.0, September 1985, Walker Richer & Quinn, Inc., 1914 North 34th, Suite 201, Seattle, WA98103

4. HP LASERJET Technical Reference Manual

5. The Peter Norton Programmer's Guide to the IBM Pc,Norton, Peter, Microsoft Press, 10700 Northrup Way, Box 97200, Bellevue, Washington 98009, 1985

6. The IBM Personal Computer from the Inside Out, Sargent, Murray and Shoemaker, Richard L., Addison-Wesley , 1984

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